SIER, a macro-economic computer game on cooperation and conflict in international economics

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SIER, A MACRO-ECONOMIC COMPUTER GAME

ON COOPERATION AND CONFLICT

IN INTERNATIONAL ECONOMICS

PROEFSCHRIFT

ter verkrijging van de graad van

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in het openbaar te verdedigen ten overstaan van

een door het college van dekanen aangewezen commissie

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door

HENRICUS JOHANNES FRANCISCUS MARIA GREMMEN

geboren te Hulst

Promotor : Prof.Dr. P. van Veen

voor Annette, Gineke en Dorine,
voor mijn ouders

Contents

Preface

No man is an island, certainly not when writing a thesis.
I was helped by many people. I would like to thank my dissertation adviser, Professor P. van Veen, for his continuous support, in moral and in many other respects. I wish to express my gratitude to all the student assistants who helped me in my research efforts, notably Hans Meertens, Ad Vollebergh, Petra de Roover, Yolande Honhoff and Greetje Frankena, to Professor Steve Miller and my colleague Dr. Ad van de Gevel for their critical remarks and suggestions on previous drafts, to Els Leyten for the way she disentagled my manuscript, to Henk op den Brouw, Drs. Hans de Vos and Inge van Niel for their kind computer assistance, to Dr. Bob Kaper for his help with some mathematical problems, to Dr. Marianne Sanders for the conscientious way she corrected my numerous English language errors and to all others who helped me.

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Finally, I thank Annette and Gineke for their patience. There were too many hours that I spent with the computer, physically or mentally, that I should have spent with them.

Hans Gremmen

Chapter 1. Formal description of the SIER Game

This chapter contains:
Section 1. History and purpose of the SIER Game. Its formal structure.
Section 2. Outline of the remaining chapters.
Section 3. On purpose and method.

Section 1. History and purpose of the SIER Game. Its formal structure

Several years ago, Professor P.van Veen, chairman of the International Economics Section of the Economics Department of Tilburg University, proposed the idea of creating a 'role-play game' between countries. The purpose of such a game would be to provide a didactic tool to teach students some aspects of standard international macro-economics. I was assigned to guide this project. Very soon it was decided that the game should take the form of a computer game, named the Simulation of International Economic Relations (SIER) Game.

From the outset it was clear that the SIER Game should first of all serve didactic purposes. It should help a teacher to clarify various basic macro-economic relationships and the way they can function over time in an interrelated world economy. Moreover, the game should show players how hard it is to reach certain goals of economic policy in such a world, even if all relationships are relatively simple and known and the number of instruments simultaneously available is sufficient.

To this end a dynamic non-linear four-country model was developed[1] containing in total 452 "global" endogenous variables. The policy instruments per player group (i.e., per country, see below) are: the level of material government expenditures, the number of civil servants, the tax rate on labour income, the tax rate on profits and interest proceeds, 3 import tariffs, wage policy, the salary of civil servants, the income per unemployed, exchange rate policy or (alternatively) a system of flexible exchange rates. If a monetary sector is included (see below), extra instruments are: open market policy and the extent to which the government deficit is financed through bonds.

As the number of relationships to be explained is rather large, the SIER Game consists of a series of games ranging from relatively simple to rather complex, where ideally students play games incorporating several successive levels of complexity. All levels have a large number of behavioural and technical relationships in common. Moreover, their formal structure (i.e., the method of playing) is identical. In each game four player groups are formed, each representing the government of a country and trying to maximize 'welfare' in its country.[2] The choice of four countries is not completely arbitrary. It facilitates trade and exchange rate blocks.[3] Moreover, although the computer uses a symmetric four-country model, if two or three countries cooperate, the 'world', in fact, becomes asymmetric.

A complete game consists of the following stages:

1. choosing the version
2. an introductory lecture
3. the game
4. evaluation.

ad 1. The version

The game leader (read: teacher) sets the current level of complexity by choosing between alternative assumptions regarding the economic model to be played with. He does so by answering the questions on his terminal screen. The options regard:

- the production function (complementarity between factors of production vs. perfect substitutability);
- the investment function (investments determined by lagged profits or by a calculated expected rate of return);
- a lagged vs. immediate impact of relative prices on the ratio of imported vs. 'home produced' consumer products;
- a game with or without an explicit monetary block;
- if a monetary sector is included: with or without international mobility of capital;
- at the outset world-wide fixed but adjustable or flexible rates of exchange[4].

By choosing between these alternatives, the game leader actually sets the values of a row of 0/1-coefficients. His choice also determines the instruments available to players. A full list of instruments is provided in Appendix 1.1. Moreover, the game leader has the option to change the coefficients in the model. In this way he can, for example, include immediate or lagged influences of consumer prices, labour productivity and/or the rate of unemployment on the nominal wage rate. Or he can introduce a positive or negative rate of growth in the labour force. Since all of these alternatives can be combined, a large number of games results.[5]

ad 2. The introductory lecture

Before the game starts, the game leader explains to the players the relationships within the model, including the welfare function (see below). To this end he can use the hand-outs that have been developed for the main varieties of the game. Each hand-out contains the assignment, the welfare function, the essential features of the current model (including an arrow scheme of the economy concerned), the initial starting position, a list of instruments and a list of symbols. To detect the dynamic behaviour of the model following impulses, the game leader can use the 'iebtest' program. With the help of this program, the game leader can calculate the outcomes of any combination of impulses by any of the four groups (or by several or all of them) for every desired number of periods (up to 1500) using only one terminal.[6] Moreover, he divides the total group of students into subgroups of 3 to 4 people, where every subgroup is supposed to represent the government of a country. Since the model in the computer is a four-country model, a maximum of 4 subgroups (governments) can play each game.[7] Thirdly, he assigns a task to all governments, which may be one of the following:

1. make sure that at the end of the game welfare in your country is higher than welfare in the other countries, or
2. make sure that at the end of the game welfare in your country is as high as possible.

"Welfare" is a figure based on the five goals of economic policy accepted in many western countries. If, as a hypothesis, governments strive for maximal chances of re-election, and those chances grow with increases in

"welfare", their economic policy should be directed at task 2 above. A disadvantage of that assignment, however, is that possibly no winner can be determined, which might demotivate students. In practice, assignment 1 was chosen as a compromise making it a precondition that a country could only be a winner if its welfare was not lower than it would have been without policy interventions (in all countries).[8]

In the basic version of the game, each country starts out with 100 "points" of welfare. This level is increased every period

1. if real private absorption of goods and services[9] increases, where the number of services is assumed to equal the number of civil servants: each civil servant is assumed to produce one (free) service per period.[10]
2. if the rate of unemployment is less than 3%. The lower unemployment, the higher the welfare increase. If unemployment exceeds the 3% level, welfare drops (the higher unemployment, the larger this drop).[11]
3. if price changes are smaller than 4%. The lower the price change (in absolute terms), the higher the rise in welfare. If prices change by more than plus or minus 4%, welfare drops (the higher the price change in absolute terms, the larger this drop).
4. if the surplus on the balance of payments is between 3 and 5 units of gold. If it equals 4, welfare rises maximally. If smaller than 3 or larger than 5, welfare drops. The further this surplus is removed from 4, the smaller the increase (or the larger the decrease) in welfare.

   The main argument to let players strive for a surplus in this respect is of a didactic nature: in a closed four-country world as assumed in the game it is of course impossible that the balance of payments of all countries would be in surplus. As a result this fourth determinant of welfare will increase competition between the player groups.

5.a) if a monetary sector is included: if the rate of interest is below 10%; or, alternatively,

b) if no monetary sector is included: if the surplus on the government account as a ratio of national (firm) output is between -1% and

+1%.[12] The optimum here is zero percent: a balanced government budget. The concrete specification of the welfare function (see below) implies that welfare is unaffected by the total of the current item and item 4, if cet. par. F is raised from 0 to a level between 0 and 4.[13] The savings by the government will (cet. par.) cause an equal surplus on the current account.

In the basic version of the game, all of these welfare items have an arbitrary equal weight: if an item scores maximally, welfare is raised by 0.25 points. Using these coefficients, in summary, the welfare function reads as

$$W = W_{-1} + 0.25(\Delta(c+m) + \Delta\ell_g) + 0.25(1-u/3)$$

$$+ 0.25(1-100|\dot{P}|/4) + 0.25 \times (1-|BB-4|)$$

$$+ \text{either: } 0.25(0.1-r) \times 100$$

$$\text{or} \quad : 0.25\left(1 - \frac{|F|}{Y} \times 100\right) \qquad (1.1)$$

where[14]

c = real private consumption of goods produced in the home country
m = private consumption of imported goods in real terms
ℓ_g = number of services consumed
u = rate of unemployment ($u \geq 0$)
$\dot{P}$ = rate of change in consumer price index
BB = surplus on balance of payments in gold
r = (nominal) rate of interest
F = surplus on government account
Y = value of firm output

However, like all coefficients of the economic model, the coefficients in the welfare function, including those weights, can be changed by the game leader. This option reflects the fact that in the SIER Game 'welfare' only functions as a datum given by political institutions to be 'maximized' by

players. The fact that the determinants of welfare are possibly intertwined is therefore irrelevant.

Although 'welfare' plays a minor role in the SIER Game as the game is primarily intended to help in teaching economics, the game leader has the option to switch to a slightly different version of the welfare equation.[15] The standard welfare function presumes that voters are in a certain respect shortsighted: the current level of final private absorption determines the current level of welfare,[16] regardless of, for example, real private consumption of home produced goods in the past. As an alternative, the game leader can choose a welfare function where current welfare is a weighted average of the levels of welfare experienced in the past[17] as measured by the welfare equation given above. In the remainder of this dissertation, however, equation (1.1) is used.

Many variations on welfare equations are possible. One could, for example, make players maximize one or two determinants out of the welfare equation given certain restrictions on the other, or give each group a different welfare equation. As such, these and other variations are interesting. The main point here, however, is that to make the Game a game, one needs a criterion to determine a winner. In this sense, any welfare equation would suffice as long as it motivates players to actively participate in the game.

ad. 3. The game

Five terminals are needed to play the game: one for the game leader and one for each of the four player groups. Ideally, the players' terminals are located in separate rooms to facilitate undisturbed and free discussions within each of them.[18] This does not mean that contacts between the groups would not be allowed. If one of the groups decided that international cooperation is desirable, in the sense of coordination of policies or, for example, if it wants to raise a customs union, "diplomats" of the country concerned could "travel" to other countries.[19]

When the game leader starts the game, the outcomes for period 1 appear on the four player screens. These outcomes are calculated by the computer on

the basis of lagged values for both the endogenous variables and the parameters, including the instruments (or rather the exogenous variables). The standard levels of those lagged endogenous and exogenous variables are filed in the computer but can be changed by the game leader when starting the game.

The outcomes for period one are at the same time the starting values for 'round' two, which is the first round where players can intervene in their economies by manipulating one or more instruments of economic policy. Their decision making process, in which they can use several types of information (see below), should be finished within a time limit specified by the game leader.[20] The computer starts calculating the results for this period as soon as all groups have typed in their desired economic policies or, if that is earlier, if the time limit has passed. In the latter case the calculations are based on the assumption that those countries that have not typed in their (complete) set of policies do not intervene in the current period.

Regularly, a few seconds after the computer starts calculating, the outcomes for this period (two) are shown to the players. At the same time, these values are the starting values for the next round (three). This procedure is repeated until the game leader decides that the game is over.[21] The country with the highest level of welfare at that point has won the game. The number of rounds to be played can be announced beforehand by the game leader ("elections will be held after period 8", for example). Alternatively, to prevent policies that are only beneficial in the short run, it can be kept secret.

During each round the player groups are given information to help them make their decisions. Two types of information are produced on their terminals[22]

1. information shown automatically
2. extra information available on request.

The first type of information concerns for both the present and the previous period

- a "welfare screen" containing the welfare levels in all four countries as well as the direct determinants of "welfare" in the country concerned
- the "main variables" of the country concerned.

The extra information concerns (on separate screens)

- "remaining real variables", for the present and the previous period
- the monetary variables, again for the present and the previous period
- impulses up to the current period
- with all screens: a separate list explaining the symbols used.

This extra information relates to economic variables in the home country. Moreover, all the above information is also available for any other previous period and for any other country. Groups can acquire the 'extra information' by answering 'Y' to the question concerned.[23]

The role of the game leader in technically running the game is limited to typing in the preferred version and the respective time limits. For optimal use of the game, however, it appeared crucial that he is available for players to provide sufficient feed-back on the economics of the model used during the computer session. As stated above, the SIER Game was not developed to serve as a substitute for a teacher, but only to provide a didactic tool.

ad 4. The evaluation

A game is closed by an evaluation based on a computer printout of all interventions and the developments in the main economic variables. This printout is available to every player immediately after the computer session.

The evaluation can take several forms. If time was short, a brief session immediately following the computer session was held giving the groups the opportunity to explain the policies they pursued and to ask clarification on certain developments that they did not understand. Moreover, such a session gives the game leader the opportunity to summarize the main developments over time and pose critical questions to the groups. And, most importantly, it gives him/her the opportunity to check (albeit superficially) whether the goals of the SIER Game were achieved or not, and whether the version played was accurate or not.

More satisfying, however, was the evaluation form used most often, where each of the player groups had to write a short paper featuring:

- the welfare equation
- main lines of intended policies and expected results
- per period: actual policies, including reactions to interventions by other countries
- per period: outcomes and explanations
- an evaluation of intended and pursued policies
- an evaluation of the usefulness of the present version of the SIER Game.

This paper was distributed to all other players and was presented to and defended before the whole group and the game leader.
With this procedure, students are not only trained in writing a paper and actively participating in a group, but were also forced to analyse and discuss the economic relationships in detail. Although it does not suffice as a scientific proof, the formal and informal reactions of the participants so far indicate that a game such as the SIER Game, especially when combined with the latter kind of evaluation, could serve as a valuable didactic tool in teaching elements of international macro-economics.

Section 2. Outline of remaining chapters

In the remaining chapters the macro-economic models used in the SIER Game are described, as well as possible alternative applications of the SIER framework. As a starting point, in Chapter 2 the relationships common to all of the SIER models models are explained. These common features are combined with one of two available investment equations and one of two available production functions. The alternative production functions are characterized by the relationship between the factors of production that are distinguished, labour and capital. In the SIER Game they are either complementary or perfectly substitutable. The way expectations with regard to net profits (the determinant of net investments) are formed can be either more or less traditional (expected net profits are supposed to equal last period's net profits) or more sophisticated: on the basis of extrapolations of a few variables, other variables, as expected output

prices and production, are calculated. And on the basis of the latter, expected profits are "calculated".[24]

Combined with the common relationships explained in Chapter 2, this leads to four main models:

Chapter 3 assuming complementary factors of production and investments determined by lagged profits

Chapter 4 assuming complementary factors of production and investments determined by "calculated" expected profits

Chapter 5 assuming substitutable factors of production and investments determined by lagged profits

Chapter 6 assuming substitutable factors of production and investments determined by "calculated" expected profits.

The models embodied in the SIER Game are described in these respective chapters that function as a guide for future game leaders. In short, Chapters 3 to 6 are characterized by the following combinations of investment and production functions:

investments depend on → / labour and capital are ↓	lagged profits	calculated expected profits
complementary	Chapter 3	Chapter 4
substitutable	Chapter 4	Chapter 6

Diagram 1.1

The way these models behave under different shocks is illustrated with the help of "tables"[25] in as far as the models concerned can be regarded as reflecting standard macro-economic theories.[26] In those tables the effects over time are depicted of certain impulses or of combinations of impulses (policy interventions) as calculated by the computer. In general, we will

discuss the impact of fiscal policy (demand policy), supply-side policy (lowering the profit tax rate) and wage rate policy. If applicable, we will do so with and without an explicit monetary sector and with flexible and 'fixed but adjustable' rates of exchange. If a monetary sector is included, we will also discuss the effects of monetary policy.
The conclusions of the simulations regarding fiscal and monetary policy, are compared to those of standard economic literature on international macro-economics in Chapter 7 (Section 1).

As the Game only intends to present elements of standard macro-economics, we will not give any overview of literature or include recent contributions. In the final chapter, Chapter 7, however, we will argue that the SIER Game can also be used as a powerful framework for research, for example to study those recent publications on international macro-economics. That chapter illustrates that the model developed here can be used in this context in at least three different respects:

1. to discuss the impact of alternative (combinations of) economic policies in alternative settings. To illustrate this, some of the results found in the tables of Chapters 3 to 6 are summarized and compared;
2. to check whether or not the policy recommendations found in existing literature still hold if the economic model on which they are based is replaced by one (or more) of the SIER models;
3. to discover the effects of a basically different behavioural assumption by inserting that assumption into the SIER framework.[27]

By no means is the project presented in this dissertation finished. As far as Chapters 2 to 6 are concerned, they give the specifications of the equations as they currently are, and, of course, all of these specifications can be developed further. Chapter 7 gives examples of how the framework built could be used as a research tool. These examples should be elaborated before completion. The dissertation merely presents a framework that could be used as a basis for both educational and research purposes.

Section 3. On purpose and method

In 1976, Lucas criticized models entailing fixed decision rules of economic agents.[28] Models using fixed parameters would lead to incorrect predictions of the impact of policy measures, especially in the longer run, as over time and due to the policy measures themselves parameters (i.e., decision rules) change. In his words, "given that the structure of an econometric model consists of optimal decision rules of economic agents, and that optimal decision rules vary systematically with changes in the structures of series relevant to the decision maker, it follows that any change of policy will systematically alter the structure of econometric models" (p.41).
As Chari describes,[29] one way to circumvent the problem that the effects of policies are dependent on the way current policies affect expected future policies and thus current decisions, is to start from the subjects' objective functions and maximize them given expected values for future policies. The latter expectations are known in circumstances where the government in the current period chooses an entire sequence of policies for this and the subsequent periods (a policy regime) and people believe those policies are indeed followed in future. This brings up the issue of the time consistency of policy: if a certain policy regime is optimal in period t, will it still be optimal for periods > t? If not, i.e., if the policy is 'time inconsistent', one could assume that people will not believe the announced policy regime, will therefore act differently than supposed when designing the optimal policy, and will thus make that policy suboptimal. See Chari.

When developing a series of models basically for educational purposes, one has to leave out economic insights, sometimes even important ones. Inclusion of everything would lead to such a large and complex model, that students would only be left with unsolved puzzles. To assume changes in expected policies and thus in decision rules (as opposed to decisions) as soon as current policies are changed, could result in this kind of puzzle. Another inference of the Lucas' critique mentioned above, however, although complicating the model, is covered to a certain extent in the

model(s) to be presented: if the economic environment changes (for instance due to policy), some of the decision rules change.

A few examples may illustrate this point.

In all models the economy may endogenously switch between an economy producing at full capacity and one producing at less than full capacity. The way output prices and production are set, adapts simultaneously. In Chapters 4 and 6, investments depend on (among other things) expected future output prices and (in Chapter 6) on expected future output. To this end, those expected values are calculated in an 'expected future product market' structured along the same lines as the market for current products. Independently from the 'regime' on the latter, this expected market is characterized as a full capacity market or a below-full-capacity market. If one of the determinants of (current and/or expected) demand and/or (current and/or expected) supply is affected, actual and expected output and output prices are influenced with its subsequent impact on investment decisions and (in Chapter 7) on consumer decisions. [30]

If labour and capital are complementary, a possibly expected shortage on the labour market (which is determined simultaneously with the 'expected product market' above) will keep entrepreneurs from net investments -even if they would be profitable if sufficient labour would be available- as they do not expect to be able to hire the extra labour. Again, if the government by its action influences the expected availability of labour (for instance by currently hiring extra civil servants) this policy influences current investment decisions.

The examples so far necessitate discontinuous decision rules. This does not hold for the following example.

In Chapter 6 an asymmetric investment decision rule is developed (and examined in Chapter 7) where the utility of expected extra profits resulting from a considered expansion of the capital stock depends on the current situation of 'the firm'. As a consequence, the current investment decision depends on all factors (like current or past governmental policy) that determine expected profitability of investments, or the current situation of firms, or both. This decision rule replaces the more conventional one where net investments are directly linked to the 'gap' between the actual stock of capital and the one that is expected to minimize production costs.

These examples may illustrate that although the models will be described below do not embody a direct influence of policy changes on decision rules, they do to a certain extent meet another inference of the 'Lucas-critique' that decision rules should not be fixed, but should depend on circumstances relevant to the decision maker. This does not imply, however, that no further research should be required in this field. To the same extent, the models' predictions about the efficay of the various policies should be modified.

As discussed above, in the Game players try to maximize 'welfare'. The algoritm in the computer model is, however, not designed to calculate 'optimal policies'. What the computer does, is calculate the effects of policy measures chosen by players under specified assumptions. By the same token, the algoritm is not developed to investigate the possible time consistency of policy.

Appendix 1.1 Lay-out of the Game

In every period the lay-out on the players' screen is alike.
When starting the game (period 1) it looks as follows.

Results (welf.- variables) period 1 , 0			for country 1 (actual and last period's values) period 1 , 0			period 1 , 0	
WELF1	99.7530	100.252	CO1 N	60.00000	60.0000	U1	2.982107	2.98211
WELF2	99.7530	100.252	M1 N	16.00000	16.0000	BB1	-.000000	0.00000
WELF3	99.7530	100.252	INFL1	-.000000	0.00000	R1	0.100000	0.10000
WELF4	99.7530	100.252	LG1	22.00000	22.0000			

Press <RETURN> to continue

Results (main variables) period 1 , 0			for country 1 (actual and last period's values) period 1 , 0			period 1 , 0	
welfare/model			distribution of income			U1	2.982107	2.98211
WELF1	99.7530	100.252	YL1 N	80.00000	80.0000	KOPT1	100.0000	100.000
WELF2	99.7530	100.252	YR1 N	-.000000	0.00000	ID1	0.000000	0.00000
WELF3	99.7530	100.252	wages and prices			other main variables		
WELF4	99.7530	100.252	PL1	0.800000	0.80000	F1	-6.00000	-5.8824
MODEL1	1.000000	1.00000	WB1	0.608000	0.60800	R1	0.100000	0.10000
national income			PLCS1	0.800000	0.80000	S1 N	-.000000	0.00000
Y1 N	100.0000	100.000	PLU1	0.640000	0.64000	BB1	-.000000	0.00000
Y1	100.0000	100.000	P1	1.000000	1.00000	ER12	1.000000	1.00000
CO1	60.00000	60.0000	PY1	1.000000	1.00000	ER13	1.000000	1.00000
I1	10.00000	10.0000	factors of production			ER14	1.000000	1.00000
G1	14.00000	14.0000	K1	100.0000	100.000	CK1	1.000000	1.00000
EX1	16.00000	16.0000	LM1	100.0000	100.000	CK2	1.000000	1.00000
M1	16.00000	16.0000	LG1	22.00000	22.0000	CK3	1.000000	1.00000
						CK4	1.000000	1.00000

Do you want to see an explanation of these symbols ?: n[31]

Do you want to see the other real variables for this country ?: y[32]

Results (other real variables) for country 1 (actual and last period's values)

period 1 ,	0	period 1 ,	0	period 1 ,	0
expenditures		**prices**		**government account**	
CO1 N	60.00000 60.0000	W1	0.800000 0.80000	BL1	24.00000 24.0000
M1 N	16.00000 16.0000	PY1 E	1.000000 1.00000	BR1	9.000000 9.00000
M12 N	5.333333 5.33333	PK1 E	0.200000 0.20000	BT1	0.000000 0.00000
M13 N	5.333333 5.33333	PL1 E	0.800000 0.80000	TRF1	20.00000 20.0000
M14 N	5.333333 5.33333	**supply**		TL1	0.240000 0.24000
M12	5.333333 5.33333	CAP1	102.9889 102.989	TR1	0.600000 0.60000
M13	5.333333 5.33333	YS1	100.0000 100.000	**price of gold**	
M14	5.333333 5.33333	Y1 E	100.0000 100.000	ER1	1.000000 1.00000
G1 N	14.00000 14.0000	**labour**		**reserves**	
I1 N	10.00000 10.0000	LV1	122.0000 122.000	RES1	100.0000 100.000
EX1 N	16.00000 16.0000	LA1	125.7500 125.750		
EX12	5.333333 5.33333	LU1	3.750000 3.75000		
EX13	5.333333 5.33333				
EX14	5.333333 5.33333				

Do you want to see an explanation of these symbols ?: n

Do you want to see the monetary variables for this country ?: y

Results (monetary variables) for country 1 (actual and last period's values)

period 1 ,	0	period 1 ,	0	period 1 ,	0
interest rate		**demand for bonds**		**interest payments**	
R1	0.100000 0.10000	OVD11	61.20000 60.0000	OP1	11.00000 10.0000
supply of bonds		OVD21	30.60000 30.0000	OG1	5.000000 4.70588
MP1	3.000000 2.94118	OVD31	30.60000 30.0000	**wealth**	
O1	17.30000 16.0000	OVD41	30.60000 30.0000	V1	306.0000 300.000
OV1	173.0000 160.000	OVDR11	30.60000 30.0000	VR1	153.0000 150.000
O11	6.120000 6.00000	OVDR12	15.30000 15.0000	**balance of payments**	
O12	3.060000 3.00000	OVDR13	15.30000 15.0000	KOB1	-.000000 0.00000
O13	3.060000 3.00000	OVDR14	15.30000 15.0000	KAB1	-.000000 0.00000
O14	3.060000 3.00000	**interest proceeds**		BB1	-.000000 0.00000
OR11	3.060000 3.00000	B1	1.000000 0.00000		
OR12	1.530000 1.50000	O01	15.00000 14.7059		
OR13	1.530000 1.50000	OOR1	7.500000 7.35294		
OR14	1.530000 1.50000	OOC1	7.500000 7.35294		

Do you want to see an explanation of these symbols ?: n

```
Do you want to see impulses given by some group up to this period ?: y
Type country number  : 1
          Impulses by group 1 up to now ( in % )

          round  1  round  0
TL1 A       0.00 %    0.00 %
TR1 A       0.00 %    0.00 %
T12 A       0.00 %    0.00 %
T13 A       0.00 %    0.00 %
T14 A       0.00 %    0.00 %
G1 A        0.00 %    0.00 %
LG1 A       0.00 %    0.00 %
PL1 A       0.00 %    0.00 %
PLCS1 A     0.00 %    0.00 %
PLU1 A      0.00 %    0.00 %
ALFA11 A   50.00 %   50.00 %
MP1 A       0.00 %    0.00 %
ER1 A       0.00 %    0.00 %

Press <RETURN> to continue :
Do you want to see an explanation of these impulse symbols ?: n


Do you want information on some (other) country on some time period ?: n33


This is the input part of impulses for country 1  at round 2

Do you want to give impulses this round ?: y


Do you want to change  tax rates or import tariffs ? : y


Type in new values ( in brackets the values are shown,
that  will  be  valid if you push the <RETURN>-key ) .


The  change ( in %-points )  of  TL
 =change in labour tax rate (in %-points)          :[  0.00]  2

The  change ( in %-points )  of  TR
 =change in profit tax rate (in %-points)          :[  0.00]  -5

The import tariff (in  %) on imports from country 2:[  0.00]

The import tariff (in  %) on imports from country 3:[  0.00]

The import tariff (in  %) on imports from country 4:[  0.00]

Are these the rates that you wanted ?: y 34


Do you want to change government purchases or the number of civil servants ?:y
```

```
Type in new values ( in brackets the values are shown,
that  will  be  valid if you push the <RETURN>-key ) .


The   change  ( in  % )
in   real   level   of   government   purchases     :[  0.00]  2

The   change  ( in  % )  in  the number of workers
employed  by  the  government                       :[  0.00]  2

Did you type the right change in total government expenditures ?: y


Do you want an exogenous change in a wage rate ?: y


Type in new values ( in brackets the values are shown,
that  will  be  valid if you push the <RETURN>-key ) .


With regard to the wage rate in the private sector,
what is the desired increase
 (as a % of last period's value)?                   :[  0.00]  -1

With regard to the wage rate in the government sector,
what is the desired increase
 (as a % of the trend in private wages)  ?          :[  0.00]

With  regard  to  the  income  of the unemployed,
what is the desired increase
 (as a % of the trend in private wages ) ?          :[  0.00]  -1

Did you type the right changes in wage rates ?: y


Do you want to change your monetary policy ?: y


Type in new values ( in brackets the values are shown,
that  will  be  valid if you push the <RETURN>-key ) .


To what extent do you want to finance your
government  deficit by monetary means ?
Please, type in  the  desired  percentage,
where   0%   means   no     monetary   financing
and   100%   means   full   monetary   financing.  :[ 50.00]  40
```

```
Apart from possible monetary financing of the
government deficit,
what percentage of last period's number of bonds
do you want your Central Bank to buy
(thereby increasing the money supply) ?            :[  0.00]  1

Did you type the right impulses concerning the money supply ?: y

Do you want  to  alter  the  exchange  rate  system
and switch to  floating  as opposed to
fixed  exchange  rates, or vice versa ?: n 35

Do you want to devalue or revalue your currency ?:y

Type in new values ( in brackets the values are shown,
that  will  be  valid if you push the <RETURN>-key ) .

Type in the desired percentage of de- or revaluation
(where a positive number indicates a devaluation)  :[  0.00]  0

The impulses are :

    2.00 %  for  TL1 A     change (in %-points) in labour tax rate
   -5.00 %  for  TR1 A     change (in %-points) in profit tax rate
    0.00 %  for  T12 A     tariff on imports out of country 2
    0.00 %  for  T13 A     tariff on imports out of country 3
    0.00 %  for  T14 A     tariff on imports out of country 4
    2.00 %  for  G1 A      additional government purchases
    2.00 %  for  LG1 A     additional civil servants
   -1.00 %  for  PL1 A     autonomous increase in private wages
    0.00 %  for  PLCS1 A   increase in income per civil servant rel. to trend
   -1.00 %  for  PLU1 A    increase in income per unemployed relative to trend
   40.00 %  for  ALFA11 A  monetary financing of government deficit
    1.00 %  for  MP1 A     autonomous increase in money supply
    0.00 %  for  ER1 A     percentage of devaluation


Before definitely deciding upon impulses
do you need further information? n 36

Did you type the right impulses ?: y 37

End of input of group 1 for period 2  .  Please wait for the results.
```

NOTES (Chapter 1)

1 Each period a player group is allowed to manipulate all available instruments (see below) and is informed on the outcomes of previous actions (by the group itself or by other players). As a consequence, the model is necessarily dynamic and all equations are formulated explicitly.

2 'Welfare' is defined below in this chapter.

3 Possible consequences of import tariffs and customs unions are discussed in Chapter 4.

4 If applicable, during the game a group of players can decide to switch from flexible rates of exchange to fixed but adjustable rates or vice versa.

5 It will be illustrated in Chapters 3 and 5, however, that it would be undesirable to combine an investment behaviour determined by lagged profits with the monetary block incorporated in the model.

6 As opposed to five in an actual game (see below). The program also entails the possibility of halting the calculation process as soon as a new stationary equilibrium is reached. This 'iebtest' program was used to produce all tables in this dissertation regarding the results of intervention.

7 It is possible to have fewer player groups. In that case the game leader decides upon the policy actions of the countries "without government".

8 Variations on assignment 1 were also used, for instance: welfare in countries 1 and 2 together should be higher than its counterpart in 3 and 4 (and vice versa). Another variation concerned the starting position: instead of identical starting positions in all countries, one of the countries started with a relatively large government deficit as a consequence of relatively high government expenditures (USA), a second started with import barriers (Japan) and the remaining two countries were joined in an exchange rate arrangement (Europe).

9 Note that absorption (as opposed to production) is included in welfare and that only final private absorption is taken into account: voters will not feel "richer" merely because of enhanced public consumption or of increased investments. Only if these extra investments lead to more employment, for example, will they feel better and the chances of re-election grow.

10 This productivity m.m. equals labour productivity in the private sector if complementary factors of production are assumed and equals the initial private labour productivity if possibilities of substitution between those factors are assumed.

11 In the model, unemployment cannot be negative.

12 Items 5a and 5b are not jointly taken into consideration because of the too obvious correlation between them.

13 If national firm output is at its initial level of 100.

14 A full list of symbols is provided in the back of this dissertation.

15 By giving coefficient c3861 a value different from its standard level of zero.

16 If W is welfare, c = real private absorption of home produced goods, m = real private absorption of imported products and ℓ_g = real consumption of services, $W = f(c,\ell_g,m...)$ leads to $dW = \frac{\delta W}{\delta c} dc + \frac{\delta W}{\delta \ell_g} d\ell_g + \frac{\delta W}{\delta m} dm + ...$, where for convenience $\frac{\delta W}{\delta c} = \frac{\delta W}{\delta \ell_g} = \frac{\delta W}{\delta m}$ and thus to the first part of the welfare equation above.

17 Welfare is then calculated along lines which are also used with other averages in the game (see under "expectations", Chapter 2): a weighted average over the past ϑ years (ϑ = life span) where the most recent year(s) get(s) the highest weight(s).

18 Especially for occasions when separate rooms are not available, the program entails the option of secret passwords for each player group. Such passwords prevent the deliberate or undeliberate use of terminals of other groups.

19 In the current version of the program groups cannot yet send messages to other participants via the network. As a consequence, if in future the game is to be played between groups in different towns, such cooperative actions could only be undertaken after telephone consultations unless the program is modified at this point.

20 The remaining time for the current period is "broadcasted" by the computer as soon as one extra minute has passed.

21 Per round the game leader sets a time limit. He can make that time limit dependent on the time effectively needed in the previous round(s). In an alternative setting, where each round lasts a week, for example, the game leader works with "iebtest" (see above), where no time limit is set. We will not discuss those alternative settings here.

22 To get an impression of the lay-out, see Appendix 1.1, where all questions and answers for one of the versions of the games are listed in chronological order.

23 Players do not need to know anything about computers to be able to play the SIER Game: following the "menu-shape" the only 'answers' they have to give during the game are Y (for yes), N (for no), < RETURN > (pushing the enter key) or a figure.

24 This hypothesis works out differently under the respective production functions.

25 To save space, tables illustrating an intervention equal in all four countries of the symmetric "SIER world" only give the outcomes for country one. Developments in the other three countries are identical. If only one country intervenes, we will assume only country 1 intervenes and the

tables will only list the results in countries 1 and 2. The developments in countries 3 and 4 are identical to those in country 2.
For convenience, the tables are bundled separately. For those who want to study the dissertation in detail, they are available on request with the author.

26 In Chapter 6 two alternative investment functions are described as they are both available in the SIER Game, a symmetric one and an asymmetric one. As the latter cannot be regarded as 'standard', the illustrations of the model's behaviour in Chapter 6 use the former investment equation. Discussion of its behaviour when the asymmetric investment equation is included is postponed to Chapter 7, regarding this equation as an extension of the basic SIER framework.

27 Several master's theses were written at the Economics Department of Tilburg University using the SIER framework in de 2nd or 3rd sense given here.

28 R.E.Lucas, Jr., 'Econometric Policy Evaluation: A Critique', in 'The Phillips Curve and Labor Markets' by K.Brunner and A.Meltzer (eds.), North-Holland, 1976.

29 V.V.Chari, 'Time Consistency and Optimal Policy Design', in Quarterly Review, Federal Reserve Bank of Minneapolis, Fall 1988, pp. 17 - 31.

30 The way expectations are formed is dealth with more extensively in Chapter 2, Section 2.1.7, and in Chapters 4 and 6.

31 After each screen containing variables, the computer asks this question. A positive answer (yes) is followed by a list of symbols concerning those variables. After each list the computer reproduces the screen this list relates to.

32 If the answer is 'no' here, the next screen is left out. This procedure also applies for the other screens to follow.

33 If the answer is "Y" here, the computer asks 'which country and which time period?', and then produces all above screens for the desired country and period.

34 If the answer is negative here, the question section concerned is reproduced. This procedure also applies with all similar questions to follow.

35 If the answer is "Y", the player is told to contact the game leader so that (s)he can type in the proper exchange rate system.

36 If the player wants more information, the computer reproduces the first screen and starts the current period all over again.

37 If the answer is "N" here, the session returns to the beginning of the "impulse-part".

Chapter 2 Description of common features

Many relations are common to all the models described in Chapters 3 to 6. Those relations which concern the real sector of the economy are described in Section 1. Those associated with the monetary sector are described in Section 2. Description of relations whose specifications depend on the assumed investment behaviour or production function are given in later chapters. Descriptions of too obvious relations have been left out.
As stated in Chapter 1, the SIER model is a symmetric model. As a consequence, this chapter only describes the equations that apply to country 1. Those regarding the other countries are analogous.

Section 1. Common features of the real sector

In all models, analytically speaking, entrepreneurs are distinguished from suppliers of labour as well as from suppliers of financial capital ('wealth holders'). Suppliers of labour immediately spend their whole income on consumer goods; they are the only private consumers. Wealth holders do nothing but invest their wealth in home currency or in bonds, issued at home or in other countries (if international capital mobility is assumed), see Section 2. Finally, entrepreneurs supply 'entrepreneurship' by combining under perfect competition two homogeneous factors of production, labour and physical capital, in order to manufacture one kind of (homogeneous) product per country. Their goal is profit maximization. The product they manufacture is a "less than perfect" substitute for the goods produced in the other three countries. International competition is based on price competition. Entrepreneurs are the owners of fixed capital after buying the amount they wish to employ. In contrast to labour, the amount of capital is fixed in the short run.

We will start the description of 'our' economy by describing the factor labour, its reward and its spending behaviour (2.1.1). The next subsection will be devoted to the factor physical capital (2.1.2). From 2.1.1 and 2.1.2 consumer expenditure and demand for investment products are 'known'. If added to government demand and exports (subject of Subsection 2.1.3), total demand can be derived. Intersection with the supply curve results in prices, output and employment, Subsection 2.1.4. In 2.1.5

some technical relations are given, while 2.1.6 presents the exchange rate equations. Subsection 2.1.7 concludes Section 1 giving the basic structure of the formation of expectations.

2.1.1. Labour/households

a. Some technical relations

Total supply of labour, ℓ_s,[1] grows exogenously at a rate $\bar{\pi}$ set by the game leader:

$$\ell_s = \ell_{s_{-1}}(1+\bar{\pi}) \tag{2.1}$$

Labour and physical capital are both assumed to be homogeneous in nature as well as internationally immobile.

Suppliers of labour can be divided into three categories:
a. those working in the private sector (ℓ_m in number)
b. those working in the government sector (ℓ_g in number)
c. the unemployed (ℓ_u in number).
Total demand for labour, ℓ_d, is calculated by adding up the first two:

$$\ell_d = \ell_m + \ell_g \tag{2.2}$$

The absolute difference between ℓ_s and ℓ_d equals the number of unemployed, ℓ_u:

$$\ell_u = \ell_s - \ell_d \tag{2.3}$$

while their relative difference after multiplying by 100% indicates the percentage unemployed, u:

$$u = \frac{\ell_s - \ell_d}{\ell_s} \times 100\% \tag{2.4}$$

The government offers an income to categories b and c, the civil servants and the unemployed. Civil servants are paid P_{LCS}, while the unemployed get P_{LU}. Both P_{LCS} and P_{LU} are connected to the wage rate in the market sector, P_L, using a 'trend-index':

$$P_{LCS} = (P_{LCS_{-1}} \times (1+\dot{P}_L)) \times (1+\overline{P_{LCS}}) \tag{2.5}$$

$$P_{LU} = (P_{LU_{-1}} \times (1+\dot{P}_L)) \times (1+\overline{P_{LU}}) \tag{2.6}$$

where

$\dot{P}_L$ = relative change in the price of labour in the market sector

$\overline{P_{LCS}}$ = autonomous relative change in the income of civil servants (policy instrument)

$\overline{P_{LU}}$ = autonomous relative change in the income of unemployed (policy instrument)

The trend index is represented by the factor $(1 + \dot{P}_L)$ in both equations (2.5) and (2.6). If the government wants the salary per civil servant (respectively per unemployed) to be raised at this percentage, $\overline{P_{LCS}}$ (respectively $\overline{P_{LU}}$) is zero. If not, $\overline{P_{LCS}}$ (respectively $\overline{P_{LU}}$) is unequal to zero.

Total payments to civil servants (ℓ_g) and unemployed (ℓ_u) are labelled 'transfers' (TRF):

$$TRF = (\ell_g \times P_{LCS}) + (\ell_u \times P_{LU}) \tag{2.7}$$

where the second term disappears if ℓ_u is smaller than or equal to 0.

As indicated above, ℓ_m represents the number of workers in the private sector. It also includes the number employers in that sector. As a reward for their labour input, they are paid the private wage rate P_L. Hence, total labour income earned in the private sector, Y_L, is calculated as

$$Y_L = \ell_m \times P_L \tag{2.8}$$

Total gross household income equals $TRF + Y_L$. If import tariffs are zero, net household income is derived by subtracting tax on labour income. Total labour tax revenue equals B_L

$$B_L = \bar{T}_L \times (Y_L+TRF) \tag{2.9}$$

where $\bar{T}_L$, the tax rate on labour income, is the third policy instrument. All labourers[2] immediately spend their whole disposable income earned in a certain period on consumer goods produced in the home country (C) or abroad (M).

Imports consist of final private consumer goods only and are charged with possibly discriminatory import tariffs (≥ 0). For instance, country 1 can levy three different import tariffs $\bar{t}_{12}$, $\bar{t}_{13}$, and $\bar{t}_{14}$ on imports out of countries 2, 3, and 4, respectively. Total import tariff revenue for country 1 amounts to BT_1, where

$$BT_1 = \bar{t}_{12}M_{12} + \bar{t}_{13}M_{13} + \bar{t}_{14}M_{14} \tag{2.10}$$

In (2.10), M_{ij} represents the value[3] of imports in i out of country j before import tariffs; those imports are charged by the percentage $\bar{t}_{ij}$, a fourth policy instrument, where $i=1,\ldots,4$ and $j=1,\ldots, i \neq j$. Since tariffs can be levied discriminatively, this creates the possibility of preferential trading clubs, free trade areas and customs unions.

b. Spending behaviour

Private consumer behaviour is expressed as

$$C = (Y_L+TRF) - (B_L+BT) - M \tag{2.11}$$

where C = private consumption of goods produced in the home market
M = value of (total) imports before tariffs.[4]

If foreign products, denoted in home currency and after import duties, fall in price, consumers will decide to import more at the expense of domestically produced goods.[5] This relation can be depicted as follows:

$$m_{ij} = \epsilon \frac{P_{y_i}}{P_{m_{ij}}} c_i \qquad (2.12)$$

where P_{y_i} = price level of a product produced in i in currency i

$P_{m_{ij}}$ = price of imports in i out of j in currency i after tariffs (see 2.13 below)

ϵ = the ratio between the amount of money spent on home produced goods ($c_i P_{y_i} = C$) and the amount spent on imports out of j ($m_{ij} P_{m_{ij}}$). ϵ is a constant implying an elasticity of substitution equal to one,

and

$$P_{m_{ij}} = P_{y_j} ER_{ij} (1+\bar{t}_{ij}) \qquad (2.13)$$

in which ER_{ij} represents the exchange rate between i and j's currency: the price of one unit of currency j in currency i.

The game leader can assume a lagged price factor in (2.12). If so, this may result in the "J-curve": the volume of imports reacts slowly to a devaluation, while prices of imports go up immediately.
As a consequence, the immediate impact of a depreciation on the demand for foreign exchange by importers is positive (rather than negative). In this circumstance the exchange rate may not restore the balance on the trade account. This point is elaborated in Chapter 3.[6] As a result, the alternative in general offered to players to choose flexible exchange rates is ruled out once the game leader chooses a lagged impact of relative prices on the import/consumption ratio.
If, on the contrary, an immediate impact is assumed, it can be shown that as long as nominal net household income is unchanged, and with all prices initially at one, an import price increase leads to a proportionate fall in imports leaving consumption of home produced goods unaffected (see Appendix 2.2). The same holds, mutatis mutandis, for an increase in the price of home produced goods.
This feature is explained by a positive substitution effect on the demand for the "other" product which is exactly offset by a negative real income

effect. Consequently, elasticity conditions are fulfilled for an improvement in the balance of payments following a depreciation of the currency and players are offered the possibility to choose flexible rates of exchange.[7]

c. The private wage rate, P_L

In its most extensive form,[8] P_L is determined by

1. the price of final private absorption, P, to the extent that wages are indexed
2. the development of labour productivity in the market sector[9]
3. the rate of unemployment, u
4. wage policy, the fifth instrument of economic policy.

The first three factors may be (partly or fully) lagged which leads to the following expression for private wages:

$$P_L = (1 + \varphi_1 \dot{P} + \varphi_2 \dot{P}_{-1} + \xi_1(\dot{y} - \dot{\ell}_m) + \xi_2(\dot{y} - \dot{\ell}_m)_{-1} - \lambda_1(b_1(u - \Omega)) - \lambda_2(b_2(u_{-1} - \Omega)) + \bar{P}_L) \times P_{L_{-1}} \qquad (2.14)$$

where $0 \leq \varphi_1, \varphi_2, \xi_1, \xi_2, \lambda_1, \lambda_2 \leq 1$; $b_1, b_2 \geq 0$

ad 1. The price of final private absorption is calculated as

$$P_i = \frac{C_i}{C_i+M_i+BT_i} P_{y_i} + \sum_{\substack{j=1 \\ j\neq i}}^{4} \frac{M_{ij}(1+t_{ij})}{C_i+M_i+BT_i} P_{m_{ij}} \qquad (2.15)$$

ad 2. Applying the Dutch procedure here, the growth in average -as opposed to marginal- productivity is taken as a determinant of wage increases.[10]

ad 3. If λ_1 and/or λ_2 are taken positive, the situation on the labour market has an impact on wages. In that case the 'strong' Phillips mechanism[11] is supposed to work. For the sake of simplicity, a symmetric system is assumed here: a certain percentage unemployment has

a wage-mitigating effect equal (in absolute terms) to the wage increasing influence of the same percentage overemployment.
The definition of over- and unemployment is less traditional. It is assumed that as long as $u < \varrho$ (a constant), a certain tension is felt in the labour market and therefore the influence on wages is positive. So, overemployment is defined as $u < \varrho$. On the other hand, unemployment is defined as $u > \varrho$: a negative influence on wages.

ad 4. By pursuing wage policy in the game, the government enhances the wage rate in the private sector relative to the outcome that would have resulted with no intervention. $\bar{P}_L$ is defined as a percentage of the wage rate of the last period.

Unless otherwise indicated, in Chapters 3 to 6 nominal wage rigidity is assumed, except for a possible wage policy (the fourth determinant). Consequences of alternative forms of indexation are analysed in Chapter 7.

2.1.2 Physical capital

Since physical capital goods (say machines) were assumed to be homogeneous in nature, their productivity is independent of the date of construction and depreciation is based on technical grounds only.[12] Each machine lasts for a fixed number of periods: Θ, the life span equal to $\frac{1}{\delta}$, where δ equals the depreciation percentage per year (see below). An installation lag of one period is assumed to facilitate an easy differentiation between the demand effect and the capacity effect of investments. Hence, the total capital stock is calculated as

$$k = \sum_{s=1}^{\Theta} i_{t-s} \qquad (2.16)$$

where k = stock of physical capital
i = volume of gross investments.[13]

Entrepreneurial investment decisions are based on expected profits. In the subsequent chapters we will make alternative assumptions regarding the

ways "expected profits" are calculated, depending, amongst other items, on the respective production functions.

2.1.3. Government behaviour and exports

The demand for home products by the government equals

$$g = (1+\bar{g})g_{-1} + \gamma(\ell_g - \ell_{g_{-1}}) \tag{2.17}$$

In (2.17)

g = material government expenditures in real terms

$\bar{g}$ = percentage autonomous increase in g relative to last period's level of g (i.e., g_{-1})

γ = coefficient indicating the amount of extra material government consumption (g) per extra civil servant

ℓ_g = number of civil servants, where

$$\ell_g = (1+\bar{\ell}_g)\ell_{g_{-1}} \tag{2.18}$$

In (2.18) $\bar{\ell}_g$ indicates the percentage autonomous increase in ℓ_g relative to the level of ℓ_g in the last period. When hired, each civil servant is 'complemented' by γ products. From then on (until fired), each civil servant produces one (free) service a period (see Chapter 1).
In (2.17) and (2.18) $\bar{g}$ and $\bar{\ell}_g$ represent the sixth and seventh policy instrument respectively.[14]

Little need be said on the fourth category in demand. Since the total world economy consists of the four 'player-countries', exports by country i (x_i) are calculated by summing up the imports by the other three countries (j) out of i:

$$x_i = \sum_{\substack{j=1 \\ j\neq i}}^{4} m_{ji} \tag{2.19}$$

2.1.4. Equilibrium in the goods market

Total demand can be derived from the previous three Subsections as:
1. demand by consumers in the home country
2. demand by the government of the home country
3. demand by investors in the home country
4. demand by consumers abroad, exports.
So,

$$Y = C + I + G + X \tag{2.20}$$

where Y represents nominal demand for goods produced by firms in i. Intersection with the supply curve results in equilibrium output, prices and employment.

The specification of the supply curve depends on the assumptions with regard to the production function. With complementary factors of production, the curve either runs horizontally or vertically (See Chapters 3 and 4). If possibilities of substitution between the two factors are assumed, it either slopes upward or is vertical (see Chapters 5 and 6).

As long as output is below full capacity, prices, in the short run, equal marginal costs - the specification of the latter being dependent on the production function chosen. If output is at full capacity, prices are set at such a level that demand does not exceed maximum supply. In both cases they equilibrate total nominal demand and nominal supply.

2.1.5. Some technical relations

The balance on the government account, represented by F, can be calculated as

$$F = B_L + B_R + BT - G - TRF - O_g \tag{2.21}$$

where O_g represents the interest to be paid by the government (see Section 2). This term disappears if no monetary sector is included.
B_R represents the revenue of taxes on profits Y_R and interest earnings, where

$$B_R = \bar{T}_{R_{-1}}(Y_{R_{-1}}) + \bar{T}_R(00) \qquad (2.22)$$

In (2.22) the coefficient $\bar{T}_R$ refers to the (uniform) tax rate on profits and interest proceeds, the next device of economic policy.

The time lag in the first term at the right hand side is due to the fact that company profits are 'received' at the end of a period. As a consequence, taxes are not paid before the next period.

00 represents total private interest earnings in the home country (see below).

Y_R is calculated as

$$Y_R = Y - Y_L - \delta kP_y - (0_p - B) \qquad (2.23)$$

where $(0_p - B)$ refers to firm interest payments minus firm interest receipts (see Section 2) and δkP_y symbolizes depreciation charges. Depreciation is based on replacement value. The final terms in (2.22) and (2.23) disappear if the game leader does not assume a monetary sector. In that case we assume an interest rate of zero percent for simplicity's sake.

If a monetary sector is included, investments are financed by issuing irredeemable bonds (whereas depreciation charges are invested in bonds) (see Section 2). Although the loans are never to be repaid, not only interest charges but also depreciation charges should be taken into account when calculating profits. Otherwise, after Θ years a one-machine company would own nothing but an eternal debt.

2.1.6. The exchange rate system

The price of one unit of gold, ER_i, is determined for each country. Dividing the respective ER_i's results in the rates of exchange between the currencies. Various exchange rate systems can be chosen. The two extremes are world-wide 'fixed but adjustable rates' and world-wide freely floating rates.

If exchange rates float freely, the respective prices of gold follow from

$$BB_1 = BB_2 = BB_3 = BB_4 = 0 \qquad (2.24)$$

where BB_i stands for the balance of payments of country i. Since in a four country world $BB_i = 0$ for i= 1, 2, 3 implies $BB_4 = 0$, one of the four equations in (2.24) is dependent. Therefore in this case, ER_4 is chosen as the numeraire of the system. As a consequence, a depreciation of currency 4 is treated in the model as an appreciation to the same extent of the other three currencies.[15]

In the case of freely floating rates, the prices of gold are set at such a level that in terms of gold, the value of incoming payments equals the value of the outflow. If capital is internationally immobile, these respective flows are calculated as follows.[16]

The gold value of the inflow into i equals

$$\sum_{\substack{j=1 \\ j\neq i}}^{4} m_{ji} \, P_{y_i} \frac{1}{ER_i} \quad \text{or} \quad P_{y_i} \frac{1}{ER_i} \sum_{\substack{j=1 \\ j\neq i}}^{4} m_{ji} \tag{2.25a}$$

while the outflow out of i to j is calculated as

$$\sum_{\substack{j=1 \\ j\neq i}}^{4} m_{ij} \, P_{y_j} \frac{1}{ER_j} \tag{2.25b}$$

Equalizing inflow and outflow results in ER_i for i=1,2,3:

$$ER_i = \frac{P_{y_i} \sum_{\substack{j=1 \\ j\neq i}}^{4} m_{ji}}{\sum_{\substack{j=1 \\ j\neq i}}^{4} m_{ij} \, P_{y_j} \frac{1}{ER_j}} \tag{2.25}$$

With <u>fixed but adjustable exchange rates</u> worldwide, the respective prices of gold are an instrument of economic policy:

$$ER_i = (1 + \overline{ER_i A})(ER_{i_{-1}}) \tag{2.26}$$

where $\overline{ER_iA}$ is the percentage increase in the price of gold in terms of currency i.[17] If $\overline{ER_iA} > 0$, the currency concerned devalues. If $\overline{ER_iA} < 0$, it revalues.

A country can independently decide to let its currency float. Its gold price will then be determined by (2.25). The price of gold in the other three currencies will then be determined by (2.26) (unless one of them wants its currency to float, as well). If three currencies are floating, the fourth country's balance of payments must be zero, as well. Consequently, if three or more countries want their currencies to float, (2.25) determines the prices of gold. If two or less currencies float, (2.26) comes into play.

2.1.7. Expectations

In a game like this it would be rather heroic to assume perfect foresight. For one thing, players in group one do not know the policy actions in the other countries in the current period, let alone in future periods. And if players (that is governments) do not have a perfect foresight, neither will private economic agents have it.

In order to determine investments in Chapters 4 and 6, information is needed with regard to expected output, expected prices, etc. For their decisions, investors are assumed to apply the part of the SIER-model that relates to the goods market (to this extent a weak form of rational expectations is applied). They expect this structure to hold also in future. Subjects have limited information regarding the factors that are exogenous to that 'expected' market (future labour supply, number of civil servants, wage rate, nominal demand and macro-economic investments[18]). They expect the future values of these factors to be extrapolations of their current values, using their weighted average growth rate over the past Θ years (including the current period, 'bounded memory') as the extrapolation factor where the most recent year gets the highest weight. Applying this procedure, for four countries expected prices and output are calculated for t+1 and t+2,[19] influencing current decisions.[20]

Although complicating the game, simple extrapolations for expected output prices and expected production would be incorrect, as the model is non-linear and especially as the supply function is 'kinked' (where the expected branch may differ from the present one, see Chapters 3 to 6).

For simplicity, this year's expected rate of depreciation of the respective currencies is calculated on the basis of their depreciations in the past θ years. Consequently, a depreciation is expected to be followed by a further depreciation. Expected interest rates, however, equal this period's level.

As far as expectations are extrapolative, they are of a destabilizing nature. For instance, a wage increase in t implies an even higher expected wage level in t+1. But as soon as θ years have passed, the expected wage level for $t+\theta+1$ is no longer influenced by the impulse in period t. If a long run equilibrium is found, expectations equal the actual values of the variable concerned. Ideally, the learning process would be determined by the size of the forecasting error (See De Jong[21]). To simplify, in our model this process is mechanic.

2. The monetary sector

Introduction

This section describes the assumed features of the monetary sector, provided the game leader decides that inclusion of such a sector would be useful.

To make the influences on interest rates, international interest payments, etc., as clear as possible, the bond market is explicitly described in the model, leaving the money market implicit.
The quality of all four bonds traded in the world is equal: per country one quality of gilt-edged bonds is traded, issued by the local government

or by firms. Hence, per country only one interest rate will be established: the rate that equalizes demand for and supply of the bond concerned.

The assumed bonds are of the 'consol' type: irredeemable bonds with a return of one (local) currency unit a period, payable after one period; therefore, the price of such a bond equals the reciprocal of the market interest rate.[22] Besides the elegance of their price formula, choosing 'consols' as the form of bonds has two main advantages:

1. possibly the future redemption of other (redeemable) bonds affects present wealth; this problem is circumvented by assuming (irredeemable) consols;[23]
2. the number of outstanding bonds equals next period's interest payments (after multiplication by one unit of the currency concerned).

In this section, we will discuss the demand for bonds (Subsection 2.2.1), the supply of bonds (Subsection 2.2.2), the equilibrium (Subsection 2.2.3) and some technical relations (subsection 2.2.4).

2.2.1. Demand for bonds

Bonds are demanded by three categories:

1. "wealth owners" (wealth holders)
2. entrepreneurs
3. the Central Bank; this category is dealt with in the next subsection.

Moreover, depreciation allowances are invested in bonds - see Subsection 2.2.3.

ad 1. Wealth owners

These people have built up wealth during the past. Their only economic activity is to invest this wealth, including its returns, in speculative cash balances (local currency) or in bonds or both. Their consumption equals zero.

The behaviour of wealth owners follows lines based on Frankel.[24]

The demand for bonds issued in the home country (OVD_{ii}) as a

ratio of total portfolio ("wealth", V_i) is determined by the difference between the home interest rate (r_i) on the one hand and outside interest rates (r_j, $j \neq i$) plus expected depreciation of the home currency, on the other.[25]

The demand for bonds issued elsewhere (OVD_{ij}) equals OVD_{jj} after allowing for differences in the respective portfolios (V_i versus V_j), multiplied by 0.5 to follow Frankel's "preferred local habitat" hypothesis. The latter implies that since, apart from possible differences in profitability, all bonds are equally attractive except for their currency denomination, the exchange rate risk on holdings of foreign bonds will make them (cet. par.) less attractive than home issued bonds. This hypothesis is followed in the SIER model in the sense that -in the starting position- in each country twice as many home issued bonds are kept in the portfolio than bonds issued in each of the foreign countries. As there are 3 foreign countries, in the starting position in total more foreign than home bonds are found in the portfolios. Obviously, changes in the determinants of the respective bond holdings may alter this ratio during a game.

ad. 2. Entrepreneurs

As far as their behaviour with regard to bond demand is concerned, the specification equals the one for 'wealth owners'. The reason they are treated separately is that the definition of their 'wealth' differs. Apart from adding net interest receipts to this portfolio as above, they also add net profits (see below).

Summarizing, private demand -in value- by non-firms for bonds issued in i and j respectively, and in currency i and j respectively, is represented by

$$OVD_{ii} = V_i \times (\zeta_{ii}\, r_i - \sum_{\substack{j=1 \\ j \neq i}}^{4} \zeta_{ij} \times (r_j + \dot{ER}^e_{ij})) \qquad (2.27)$$

and for j not equal to i:

$$OVD_{ij} = 0.5 \times \frac{OVD_{jj}}{V_j} \times \frac{V_i}{ER_{ij}} \qquad (2.28)$$

Given the chosen values for the parameters ζ_{ii} and ζ_{ij}, (2.27) and (2.28) have the following properties:

- an increase in 'wealth' leads to a proportionate increase in all portfolio assets
- cet. par. (i.e., with unchanged exchange rate expectations, for example) an increase in r_i leads to an increase in the demand by investors in all countries for bonds issued in i, at the expense of money holdings as well as at the expense of holdings of other bonds
- a comparable increase in all interest rates cet. par. causes the demand for all bonds to rise at the expense of the demand for cash[26]
- due to the preferred local habitat feature, the (absolute) increase in the demand for home issued bonds is cet. par. larger than the increase in the demand for those bonds in each of the outside countries, if their (relative) growth is equal
- a devaluation of the home currency (ER_{ij} in (2.28) rises) at given wealth causes a decline in the demand for foreign bonds. (For the impact on wealth, see eq. 2.29.) By the same token, demand for i-bonds by countries j goes up. In other words, cet. par. a devaluation causes a surplus on the capital balance. Since portfolio equilibrium is restored instantaneously, cet. par. the next period the capital balance equilibrium is restored.[27]

For obvious reasons, (2.28) as well as the final term in brackets in (2.27) disappears if international mobility of capital is excluded.

In fact, (2.27) and (2.28) only determine the desirability of home and foreign bonds. If interest rates are high enough, the total desired stock of bonds by citizens of country one, for example, could exceed the value of their total wealth. In the computer model a mechanism is built in to prevent this. If in country one the desired bond holdings, as calculated by (2.27) and (2.28), would amount to 110% of wealth, for example, all stocks desired by country one's citizens are cut by 10% when calculating their actual demand for bonds: no more than 100% of wealth can be invested in bonds.

A similar mechanism is built in to prevent an extremely low or even negative bond demand: at least 2% (1%) of wealth is supposed to be invested in home (respectively in each of the foreign) bonds.

Net interest earnings, of both wealth owners and entrepreneurs, as well as last period's net profits of entrepreneurs are added to the asset portfolio, V_i. Consequently, this portfolio is calculated as

$$V_i = V_{i_{-1}} + OO_i(1-\bar{T}_{R_i}) + (1-\bar{T}_{R_{i_{-1}}})Y_{R_{-1}} + \Sigma_j(ER_{ij}\frac{O_{ij}}{r_j})_{-1}(\dot{ER}_{ij}-\dot{r}_j) \qquad (2.29)$$

where the final term relates to the exchange rate induced wealth effect as well as to the interest induced wealth effect.[28] The former is defined as the change in (existing) wealth caused by changes in exchange rates. If wealth owners in country 1, for example, own bonds issued in country 2, at given market prices in country 2 (that is at given r_2) these bonds increase in value measured in currency 1, if currency 2 appreciates.[29] This effect on V_i equals

$$(ER_{ij}\frac{O_{ij}}{r_j})\dot{ER}_{ij} \qquad (2.30)$$

The interest induced wealth effect is measured analogously as

$$-(\frac{ER_{ij}O_{ij}}{r_j})(\dot{r}_j) \qquad (2.31)$$

The terms in brackets in (2.30) and (2.31) are lagged in (2.29) indicating that a second order effect is neglected.

In (2.29) interest proceeds in country i (in currency i), labelled OO_i, are calculated as

$$OO_i = O_{ii_{-1}} + \sum_{\substack{j \\ i\neq j}} (O_{ij_{-1}} \times ER_{ij}) \qquad (2.32)$$

where $O_{ij_{-1}}$ (number of bonds issued in j held in i in the previous period) is calculated on the basis of OVD_{ij} as

$$O_{ij} = r_j \times OVD_{ij} \qquad (2.33)^{30}$$

2.2.2. Supply of bonds

Bonds are supplied by
1. the government, to finance (part of) its deficit
2. entrepreneurs, to finance their investments
3. the Central Bank.

ad 1 and 3 Supply by government/Central Bank

Technically, a government deficit is first financed for 100% through the issuance of bonds. But in the same period, a player group can decide to finance a fraction of the same deficit with monetary means. If so, the Central Bank buys bonds issued by the government of that country to the extent $\bar{\alpha}_1$ - defined as a percentage of the current deficit. The remainder, $(1-\bar{\alpha}_1)$, is financed through an increase in the bond supply.[31] $\bar{\alpha}_1$, the percentage of the government deficit financed with monetary means, is the first extra policy instrument available to players if a monetary sector is included. The second pertains to open market operations carried out irrespective of the government deficit, $\overline{MP}$.

The total expansion of the money supply due to open market operations, MP, equals

$$MP = \bar{\alpha}_1(-F) + \frac{1}{r}\,(\overline{MP}\ O_{-1}) \qquad (2.34)$$

where $\overline{MP}$ is defined as the percentage of last period's number of bonds the central bank wants to buy.[32] We assume open market operations are carried out only with local holders of government bonds.

As we consider the Central Bank to be a part of the government, on balance the government only pays interest on bonds which the public held in the last period. Those interest payments are calculated as

$$O_g = O_{g_{-1}} + r_{-1} \times (-F_{-1} - MP_{-1}) \qquad (2.35)$$

where F is the government budget surplus.[33]

ad 2 Supply by investors

Entrepreneurs finance their investments externally by issuing bonds to the extent $i \times P_y$, the value of investment.[34]
Consequently, interest payments by firms are calculated as

$$O_P = O_{P_{-1}} + r_{-1} \times (i_{-1} \times P_{y_{-1}}) \tag{2.36}$$

The total stock of bonds held by the public and issued in i -either by the government or by firms- equals O_i, where

$$O_i = O_{i_{-1}} + r(-F + i \times P_y - MP) \tag{2.37}$$

(2.37) states that the increase in the number of bonds issued in country i equals the government deficit plus the value of investments corrected for both the part of the government deficit not financed through bonds and the open market operations. To get numbers of bonds, this amount of money is adjusted for the price of consols, the inverse of the rate of interest.

2.2.3. The equilibrium

The interest rate adjusts to equilibrate demand for bonds issued in i and supply of these bonds. The stock of bonds desired by non-firms as calculated by (2.27) and (2.28) should be summed with demand for bonds by firms, TT. Firms are assumed to invest depreciation allowances in local bonds.[35] The value of bonds held by firms equals

$$TT = TT_{-1} + \delta k P_y \tag{2.38}$$

These holdings as well as their interest revenues, labelled B, are treated separately in the model from holdings and earnings by entrepreneurs (and wealth owners). In a stationary economy, firm interest payments, O_P, and interest receipts, B, rise (absolutely) to the same extent, leaving Y_R unaffected.

To create equilibrium,

$$r_i = \frac{O_i}{\sum_j OVD_{ji} + TT_i} \tag{2.39}$$

2.2.4. Some technical relations

If the game leader decides to allow for international capital mobility, in the definition of the balance of payments, besides the trade balance (labelled SN), one should consider the capital as well as the debt service account. To start with the former, the balance on the capital account in home currency, KAB, equals the increase in foreign holdings of 'our' bonds minus the increase of 'our' holdings of foreign bonds, both in home currency. So,

$$KAB_i = \sum_{\substack{j=1 \\ j\neq i}}^{4} \left(\frac{dO_{ji}}{r_i}\right) - \sum_{\substack{j=1 \\ j\neq i}}^{4} \left(\frac{dO_{ij}}{r_j} \times ER_{ij}\right) \tag{2.40}$$

If the balance on capital account in terms of gold is needed, as in the welfare function (see Chapter 1), KAB_i is divided by the price of gold, ER_i.

The balance on the service account, again in home currency, KOB, equals the difference in last year's 'home' holdings of foreign bonds corrected for the exchange rate concerned, on the one hand, and last year's foreign holdings of home bonds, on the other:

$$KOB_i = \sum_{\substack{j=1 \\ j\neq i}}^{4} (O_{ij_{-1}} \times ER_{ij} - O_{ji_{-1}}) \tag{2.41}$$

Again, if the KOB in terms of gold is needed, KOB is divided by the price of gold.

In case of flexible exchange rates and international capital mobility, the prices of gold in three out of the four countries are deduced by equalling all incoming and outgoing flows of money.

The incoming flows in terms of gold are derived from (2.25)a, (2.40) and (2.41), where the latter two should be adjusted for the price of gold in country i, ER_i.
Incoming flows are calculated as

$$\sum_{\substack{j=1 \\ j\neq i}}^{4} \left(P_{y_i} \frac{1}{ER_i} m_{ji} + \frac{1}{ER_i} \frac{dO_{ji}}{r_i} + O_{ij_{-1}} \frac{1}{ER_j} \right) \qquad (2.42)a$$

while outgoing flows equal

$$\sum_{\substack{j=1 \\ j\neq i}}^{4} \left(m_{ij} P_{y_j} \frac{1}{ER_j} + \frac{dO_{ij}}{r_j} \frac{1}{ER_j} + \frac{O_{ji_{-1}}}{ER_i} \right) \qquad (2.42)b$$

ER_i should be such that (2.42)a equals (2.42)b, hence:

$$ER_i = \frac{\sum_{\substack{j=1 \\ j\neq i}}^{4} \left(P_{y_i} m_{ji} + \frac{dO_{ji}}{r_i} - O_{ji_{-1}} \right)}{\sum_{\substack{j=1 \\ j\neq i}}^{4} \left(m_{ij} P_{y_j} \frac{1}{ER_j} + \frac{dO_{ij}}{r_j} \frac{1}{ER_j} - O_{ij_{-1}} \frac{1}{ER_j} \right)} \qquad (2.42)$$

If fixed exchange rates are assumed, exchange rates are determined in the same way as without a monetary sector. The balance of payments definition - in gold - then reads

$$BB = (SN + KAB + KOB)/ER \qquad (2.43)$$

Appendix 2.1 Summary of equations/expressions of Chapter 2

(2.1) $\ell_s = \ell_{s_{-1}} (1+\bar{\pi})$

(2.2) $\ell_d = \ell_m + \ell_g$

(2.3) $\ell_u = \ell_s - \ell_d$

(2.4) $u = \frac{\ell_s - \ell_d}{\ell_s} \times 100\%$

(2.5) $P_{LCS} = (P_{LCS_{-1}} \times (1+\dot{P}_L)) \times (1+\overline{\dot{P}_{LCS}})$

(2.6) $P_{LU} = (P_{LU_{-1}} \times (1+\dot{P}_L)) \times (1+\overline{\dot{P}_{LU}})$

(2.7) $TRF = (\ell_g \times P_{LCS}) + (\ell_u \times P_{LU})$

(2.8) $Y_L = \ell_m \times P_L$

(2.9) $B_L = \bar{T}_L \times (Y_L + TRF)$

(2.10) $BT_1 = \bar{t}_{12} M_{12} + \bar{t}_{13} M_{13} + \bar{t}_{14} M_{14}$

(2.11) $C = (Y_L + TRF) - (B_L + BT) - M$

(2.12) $m_{ij} = \varepsilon \frac{P_{y_i}}{P_{m_{ij}}} c_i$ or $m_{ij} = \varepsilon \left(\frac{P_{y_i}}{P_{m_{ij}}}\right)_{-1} c_i$

(2.13) $P_{m_{ij}} = P_{y_j} ER_{ij} (1+\bar{t}_{ij})$

(2.14) $P_L = (1 + \varphi_1 \dot{P} + \varphi_2 \dot{P}_{-1} + \xi_1 (\dot{y} - \dot{\ell}_m) + \xi_2 (\dot{y} - \dot{\ell}_m)_{-1}$

$- \lambda_1 (b_1 (u - \Omega)) - \lambda_2 (b_2 (u_{-1} - \Omega)) + \bar{\dot{P}}_L) \times P_{L_{-1}}$

$$(2.15)\quad P_i = \frac{C_i}{C_i+M_i+BT_i} P_{y_i} + \sum_{\substack{j=1 \\ j\neq i}}^{4} \frac{M_{ij}(1+t_{ij})}{C_i+M_i+BT_i} P_{m_{ij}}$$

$$(2.16)\quad k = \sum_{s=1}^{\Theta} i_{t-s}$$

$$(2.17)\quad g = (1+\bar{g})g_{-1} + \gamma(\ell_g - \ell_{g_{-1}})$$

$$(2.18)\quad \ell_g = (1+\bar{\ell}_g)\ell_{g_{-1}}$$

$$(2.19)\quad x_i = \sum_{\substack{j=1 \\ j\neq i}}^{4} m_{ji}$$

$$(2.20)\quad Y = C + I + G + X$$

$$(2.21)\quad F = B_L + B_R + BT - G - TRF - O_g$$

$$(2.22)\quad B_R = \bar{T}_{R_{-1}}(Y_{R_{-1}}) + \bar{T}_R(00)$$

$$(2.23)\quad Y_R = Y - Y_L - \delta k P_y - (O_p - B)$$

$$(2.24)\quad BB_1 = BB_2 = BB_3 = BB_4 = 0$$

$$(2.25)\quad ER_i = \frac{P_{y_i} \sum_{\substack{j=1 \\ j\neq i}}^{4} m_{ji}}{\sum_{\substack{j=1 \\ j\neq i}}^{4} m_{ij} P_{y_j} \frac{1}{ER_j}}$$

$$(2.26)\quad ER_i = (1 + \overline{ER_i A})(ER_{i_{-1}})$$

$$(2.27)\quad OVD_{ii} = V_i \times (\zeta_{ii} r_i - \sum_{\substack{j=1 \\ j\neq i}}^{4} \zeta_{ij} \times (r_j + \dot{ER}^e_{ij}))$$

(2.28) $$OVD_{ij} = 0.5 \times \frac{OVD_{jj}}{V_j} \times \frac{V_i}{ER_{ij}}$$

(2.29) $$V_i = V_{i_{-1}} + OO_i(1-\bar{T}_{R_i}) + (1-\bar{T}_{R_{i_{-1}}})Y_{R_{-1}} + \sum_j (ER_{ij}\frac{O_{ij}}{r_j})_{-1}(\dot{ER}_{ij}-\dot{r}_j)$$

(2.30) $$(ER_{ij}\frac{O_{ij}}{r_j})\dot{ER}_{ij}$$

(2.31) $$-(\frac{ER_{ij}\,O_{ij}}{r_j})\dot{r}_j$$

(2.32) $$OO_i = O_{ii_{-1}} + \sum_{\substack{j \\ i\neq j}} (O_{ij_{-1}} \times ER_{ij})$$

(2.33) $$O_{ij} = r_j \times OVD_{ij}$$

(2.34) $$MP = \bar{\alpha}_1(-F) + \frac{1}{r}(\overline{MP}\,O_{-1})$$

(2.35) $$O_g = O_{g_{-1}} + r_{-1} \times (-F_{-1}-MP_{-1})$$

(2.36) $$O_P = O_{P_{-1}} + r_{-1} \times (i_{-1} \times P_{y_{-1}})$$

(2.37) $$O_i = O_{i_{-1}} + r(-F + i \times P_y - MP)$$

(2.38) $$TT = TT_{-1} + \delta k\, P_y$$

(2.39) $$r_i = \frac{O_i}{\sum_j OVD_{ji} + TT_i}$$

(2.40) $$KAB_i = \sum_{\substack{j=1 \\ j\neq i}}^{4} (\frac{dO_{ji}}{r_i}) - \sum_{\substack{j=1 \\ j\neq i}}^{4} (\frac{dO_{ij}}{r_j} \times ER_{ij})$$

(2.41) $$KOB_i = \sum_{\substack{j=1 \\ j\neq i}}^{4} (O_{ij_{-1}} \times ER_{ij} - O_{ji_{-1}})$$

$$(2.42)\quad ER_i = \frac{\sum_{\substack{j=1 \\ j\neq i}}^{4} \left(P_{y_i} m_{ji} + \frac{dO_{ji}}{r_i} - O_{ji_{-1}}\right)}{\sum_{\substack{j=1 \\ j\neq i}}^{4} \left(m_{ij} P_{y_j} \frac{1}{ER_j} + \frac{dO_{ij}}{r_j} \frac{1}{ER_j} - O_{ij_{-1}} \frac{1}{ER_j} \right)}$$

$$(2.43)\quad BB = (SN + KAB + KOB)/ER$$

Appendix 2.2 The effects of price changes on consumption

If

(1) $\bar{A}$ = fixed nominal consumer spending

(2) P_m = after tariff price of imports in currency of the importing country

(3) P_y = price of home produced goods

(4) m = import in real terms

(5) c = consumption of home produced goods in real terms

(6) P = average price of consumption = $\frac{cP_y}{mP_m + cP_y} P_y + \frac{mP_m}{mP_m + cP_y} P_m$

(7) $m = \varepsilon \frac{P_y}{P_m} c$, following (2.12)

(8) initially $P_y = P_m = 1$ (= P)

then (7) $\rightarrow mP_m = \varepsilon\, cP_y$ in (6)

$$\rightarrow P = \frac{\varepsilon}{1+\varepsilon} P_m + \frac{1}{1+\varepsilon} P_y = \frac{1}{1+\varepsilon} (\varepsilon P_m + P_y)$$

$$\rightarrow dP = \frac{1}{1+\varepsilon} (\varepsilon dP_m + dP_y) \qquad (9)$$

(1), (8) $\rightarrow dm + dc = d(\frac{\bar{A}}{P}) \rightarrow dc = -\bar{A}\, dP - dm$

Since $A = (1+\varepsilon)\, cP_y$,

this leads to

$$dc = -(1+\varepsilon)\, c\, dP - dm \qquad (10)$$

$$(7), (8) \rightarrow dm = \varepsilon\, dc + \varepsilon c\, d(\frac{P_y}{P_m}) = \varepsilon\, dc + \varepsilon c(dP_y - dP_m) \qquad (11)$$

(11) and (9) in (10):

$$dc = \left(\frac{-c\varepsilon + \varepsilon c}{1+\varepsilon}\right) dP_m - c\, dP_y \qquad (12)$$

where the first term on the right hand side shows that an increase in P_m has two compensating effects on c: an income effect and a substitution effect, respectively. Consequently,

$$\dot{c} = -P_y \qquad (13)$$

Furthermore, (13) and (9) in (10) leads to

$$\dot{m} = -P_m \qquad (14)$$

Appendix 2.3 The price of consols

The price of consols is based on the net present value of future interest returns. If citizens of country i pay taxes on their interest proceeds in country i, the rate of time preference equals the net market interest rate and T_R is the tax rate on interest earnings, this present value equals

$$(1-T_R)\left[\frac{1}{1+(1-T_R)\,r_i} + \frac{1}{(1+(1-T_R)\,r_i)^2} + \ldots + \frac{1}{(1+(1-T_R)\,r_i)^n}\right]$$

for $n \to \infty$ (irredeemable bonds).
This can be rewritten as:

$$\left(\frac{1-T_R}{1+(1-T_R)\,r_i}\right) / \left(1 - \frac{1}{1+(1-T_R)\,r_i}\right) = \frac{(1-T_R)}{(1-T_R)\,r_i} = \frac{1}{r_i}.$$

This derivation does not hold if the T_R in the numerator is not the same as the one in the denominator, see Chapter 4, Section 4C.

NOTES (Chapter 2)

1 Unless otherwise indicated, all symbols used indicate absolute magnitudes and refer to country i where i = 1,...,4 and to the present period, t. Dashes on top of symbols refer to exogenuity. They are predetermined by the game leader, just as coefficients in the model, or can be fixed by players. Dotted variables symbolize relative changes. The subscripts 't-1' or '-1' indicate a time lag of one period. The equations are summarized in Appendix 2.1.

2 'Labourers' is defined as working and non-working people, unless otherwise indicated.

3 Upper case symbols indicate values, lower case indicate real terms (volumes).

4 An alternative to this more or less traditional consumption function would be consumption based on a so-called life cycle model as discussed by Mervyn King in "The economics of savings, a survey of recent contributions", 1985 in "Frontiers of Economics" by K. Arrow and S. Houkapojah (eds.). A modest attempt to include one element of this kind of theory is made in Chapter 7, where, following Van Wijnbergen, consumer behaviour is influenced by considerations of intertemporal substitution.

5 We disregard transport costs and the like.

6 See Chapter 3, Section 3A, under heading 'a', when a unilateral government expenditure increase is discussed .

7 The validity of this argument is enhanced if international mobility of capital is assumed. See Section 2.

8 If wished, the game leader can skip one or more of the determinants mentioned here.

9 By definition this determinant disappears in case of complementarity between the factors of production.

10 See Van Schaik, 'Naar Een Empirische Macro-Economie', Stenfert Kroese, Leiden, 1981, p.63.

11 See Van Schaik, same reference, p.64.

12 This contrasts with the assumption of a heterogeneous capital stock as in 'Vintaf', one of the models of the Dutch Central Planning Bureau (CPB) in 'Investeringen, Lonen, Prijzen en Arbeidsplaatsen', Occasional Papers, aug. 1974, CPB, The Hague.

13 Suppose θ = 10. Investments in t-10, installed in t-9 are the oldest machines in operation in period t. In t+1 they will be out of operation. Hence, equation (2.16) results.

14 Strictly speaking, to treat both the number of civil servants as well as their salary as exogenous policy variables may lead to contradictory situations. With a homogeneous labour market, in reality a government

paying a lower wage rate than the private sector, will in general not be able to hire extra labour if full employment exists. For convenience, we disregard this problem here.

15 With ER_4=1, the three equations would, however, be sufficient to determine the relative prices of gold (i.e. the exchange rates between the currencies). But since the balance of payments in terms of gold has to be taken into account while determining welfare, we need the respective (absolute) prices of gold as well.

16 For the prices of gold with international capital mobility, the reader is referred to the next section.

17 $\overline{ER_iA}$ is the devaluation percentage. The 'A' (autonomous) is added here to facilitate a clear distinction between this policy variable (the devaluation percentage) and the left hand side (the exchange rate).

18 The latter factor is only needed in as far as expectations are formed with regard to period t+2. See Chapters 4 and 6. When analyzing indexation in Chapter 7, expected wage rates are no longer based on extrapolation.

19 For the precise ways, see Chapters 4 and 6.

20 In Chapter 7, on the basis of the same information, consumer decisions are formed. Here 12 interrelated goods markets are calculated simultaneously.

21 Eelke de Jong, 'Expectation Formation: Criteria and an Assessment',in De Economist, 1988, nr 4, vol 136, pp. 435-467.

22 Assuming taxes on interest earnings in country i are paid in that same country and that the price of bonds is based on the net present value of future interest returns. See Appendix 2.3.

23 See Barro, "Are Government Bonds Net Wealth?" in Journal of Political Economy, 1974, pp. 1095-1117. The possibility of a negative impact on wealth of (capita-lized) future tax increases necessary to pay the government interest charges, is for simplicity neglected here.

24 Jeffrey A. Frankel, 'Monetary and Portfolio-Balance Models of Exchange Rate Determination', in 'Economic Interdependence and Flexible Exchange Rates' by J. Bhandari and B. Putnam (eds.), 1983, pp.85-115.

25 This formulation ignores a second order effect equal to the expected rate of depreciation times the foreign interest rate. Since $r^e = r$ (see above), changes in the price of bonds are not expected. Therefore, an expected financial gain (or loss) caused by expected price increases (or decreases) is not included as a determinant of the demand for bonds.

26 This positive effect of a rise in interest rates on the share of total assets invested in bonds is in compliance with H. Visser, 'Monetaire Theorie', Stenfert Kroese, Leiden, 1980, p. 101/102, who states that the positive substitution effect normally outweighs the possibly negative income effect here.

27 We disregard for the moment the expected further devaluation in the next period, giving rise to a capital flight, as well as the fact that a devaluation of say 2% increases the value of wealth in home currency by a fraction smaller than 2%. Both effects are dealt with below.

28 For the latter, the reader is referred to H. Visser, same reference, p.169.

29 Of course, this effect is only included in (2.29) if international capital mobility is assumed.

30 Equations (2.27), (2.28), (2.29), (2.32) and (2.33) determine OVD_{ii}, OVD_{ij}, V, OO and O_{ij} respectively. For players' convenience, in the model actually used in the game these totals are split up between wealth owners and entrepreneurs.

31 Since labourers consume their complete net income, we postulate they only possess transaction cash balances, no speculative ones, while wealth owners and entrepreneurs only hold speculative cash.
If demand for transaction balances changes, as a result of economic growth for example, monetary authorities respond to this demand, thus leaving the interest rate unaffected. They accomodate the transactions demand for money. To simplify, the open market operations needed to achieve this are left out. This behaviour implies sterilization of the monetary consequences of a possible trade balance disequilibrium, where in the remainder of the dissertation it is assumed that in this respect enough international reserves are available.

32 In the game, $\bar{\alpha}_1$ is constant each period unless players want to change it, whereas $\overline{MP}$ falls back to zero after an intervention. This feature is used in Chapter 4, Section 4B, to differentiate between a one time and a continuous monetary expansion.

33 To the extent $(1-\bar{\alpha}_1)$ a positive surplus on the government budget is 'financed' by buying bonds (previously issued by the government concerned) from the public.

34 The possibility of internal financing could only be usefully incorporated if the net interest rate paid by debtors could differ from the net interest rate received by creditors, which is assumed not to be the case. If those interest rates are equal, internal and external financing result in an equal net profitability of investments and no straightforward decision rule between the two alternatives is available. Therefore, we simply assume that firms finance their investments externally and at the same time invest their depreciation allowances in local bonds. If the latter is for the moment regarded as the purchase of a firm's own bonds, a solvency problem need not arise.

35 This way, in a stationary economy, once a machine is fully depreciated a firm owns bonds to an amount equal to the external debt incurred to buy the machine concerned.

Chapter 3 Complementary factors of production, investments determined by lagged profits

This chapter contains three sections:

Section 1: Introduction. Discussion of the production function and the assumed investment behaviour.
Section 2: Patterns of adjustment
Section 3: Illustrating the model: simulations

Section 1. Introduction

Two basic assumptions differentiating this chapter from the ones to follow relate to

1. the macro economic production function, characterized by complementary factors of production and
2. the assumed investment behaviour.

ad 1 Complementarity between factors of production implies that firms, regardless of their output, need a fixed amount of labour per unit of output (α), as well as a fixed amount of capital[1] (κ). Denoting the output volume by y leads to

$$\ell_m = \alpha y \tag{3.1}$$

and

$$k_v = \kappa y \tag{3.2}$$

where k_v equals the amount of capital actually in use.

With complementarity, the isoquant is represented by a dot in a k,l-schedule.

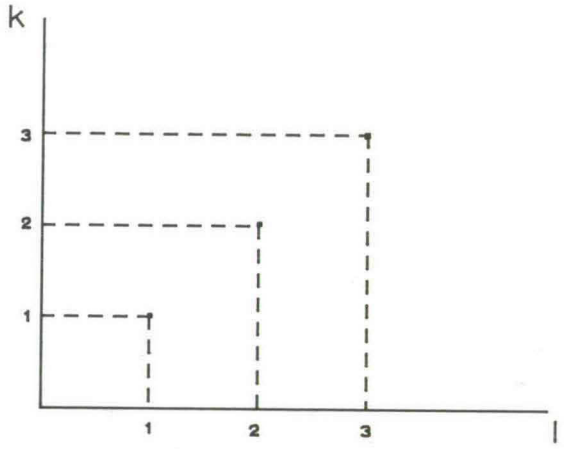

Diagram 3.1

Since we assume that both α and κ equal one, the three "dot-isoquants" in Diagram 3.1 depict output volumes of 1,2, and 3 respectively.
The dot-feature implies that at given output levels, inputs of labour and capital are fixed and do not depend on their relative prices. This contrasts with a production function reflecting possibilities of substitution between the factors of production, as will be assumed in Chapters 5 and 6.

A second distinction between the alternative production functions (complementarity vs. perfect substitution) is that in the event of substitution, the fixed factor (capital) will always be fully employed while at given output levels, labour costs will be minimized. Capital costs are incurred anyhow and cost minimization in the former case boils down to minimization of the cost of labour. With complementary factors of production, however, underutilization of fixed capital is obtained if output is smaller than could be produced if all capital were to be employed. That is, if

$$y < \frac{1}{\kappa} k \qquad (3.3)$$

where k represents the stock of capital available.

ad 2 As described by Kopcke,[2] in general 5 alternative investment functions can be distinguished

1. **The accelerator model**, with investment depending on output; although in principle suited especially for models assuming complementary factors of production, it is less appropriate for models where capital may be under-utilized[3] as the SIER model
2. **The neo-classical model** where investments depend on output, output prices and relative capital costs. This approach is used in the SIER model if factors of production are substitutable (i.c. Chapter 6)
3. **Tobin's Q**; this approach is not suitable in our model as we do not distinguish equity.
4. **Autoregressive approach** where investments are determined by past investments. As students will not learn much from such an investment equation, it is not suitable for our game.
5. **Cash flows**. Literature provides various reasons to include cash flow as a determinant for investments. Kopcke argues that the cash flow is "the preeminent and most convenient source of financing (investments)" (p. 24) and "because cash flow at once measures profitability and the capacity for attracting external financing, the size of the capital budget depends on the available cash flow." (p.24). Scotland[4] states "cash flows can affect corporate investment in two ways. First, increased cash flow suggests to the firm greater profitability in the future. In seeking to meet its objective of maximizing its own net worth, the firm increases its demand for capital. Second, increased cash flow permits greater use of internal funds as a financing source compared to equity or debt issues."(p. 6/7)

As 'cash flow' as a determinant produces a rather simple investment equation, which is didactically interesting, we will follow this approach in Chapters 3 and 5.

If share holders are not distinguished, as in the SIER model, the cash flow equals net profits and depreciation allowances.

We assume that net investments depend on lagged net profits, and that replacement (c.q. autonomous) investments equal depreciation.[5]

Regarding net investments, the lag is defended in two ways. First, as discussed in the previous chapter, profits are received at the end of a

period and cannot be spent before the next period. Second, for computational reasons a time lag is needed between a decision to invest and the actual investment (i.e., the purchase of the machine). If the first (decision to invest) depends on actual net profits, the second (the investment) depends on lagged profits.[6]

As far as replacement investment is concerned, we follow the usual assumption (see Jorgenson, Scotland[7]) that they equal depreciation.[8]

In summary, net investments are positively related to lagged net profits. That is:

$$I - \delta k p_y = (1-\bar{T}_{R_{-1}})Y_{R_{-1}} \tag{3.4}$$

or, since

$$I = i \times p_y \,, \tag{3.5}$$

$$i = (1-\bar{T}_{R_{-1}}) \frac{Y_{R_{-1}}}{p_y} + \delta k \tag{3.6}$$

Nevertheless, this equation has a drawback. It implies that if last year's capital stock (and prices of final products, and prices of labour and capital, and so on) led to net profits, entrepreneurs will decide to enlarge the capital stock. But positive profits in the past do not necessarily imply positive net returns on new machines. Expected profitability should play a role here.

The alternative to equation (3.6), investments determined by expected profitability of those investments, will be used in chapters to follow. For a comparison of the two with complementary factors of production, the reader is referred to Chapter 4.

If the game leader decides to choose 'complementary factors of production' in combination with 'investments determined by lagged profits', the equations given in Chapter 2 are complemented with equations (3.1), (3.2) and (3.6).

Besides the production function and the investment function, firm output prices (P_y) and firm output (y) need to be specified. In other words, the point of intersection between the supply curve, y_s, and the demand curve, y_d, should be determined.[9] See Diagram 3.2.

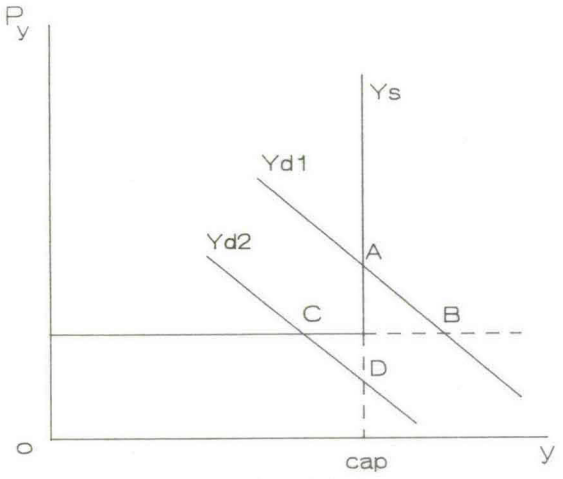

Diagram 3.2

With complementary factors of production, the supply curve (i.e., the marginal cost curve) has two branches. Starting at the point of zero output, provided physical capital is available and labour can be acquired, the first products are manufactured by hiring labour at the given price P_L. Since the labour coefficient α is constant and assumed 1, the first branch runs horizontally at the level P_L. In this part of the supply curve, the output price equals marginal (=average) labour costs ($Y_L/y = P_L$) and the volume of production is determined by demand. Therefore, the 'demand range' is said to apply, which is indicated by the computer by the

value '0' for the endogenous variable 'model'. Point C in Diagram 3.2 serves as an example.

All extra products are supplied this way, until no extra production capacity is available: the point where 'cap' is reached in the diagram. 'Cap' is the minimum of the production capacity of capital, $\frac{1}{\kappa}$ k, and the one of labour, $\frac{1}{\alpha}$ $(\ell_s - \ell_g)$, where ℓ_s and ℓ_g are exogenous -see equations (2.1) and (2.18)- and the factor $(\ell_s - \ell_g)$ represents the maximum number of people that can be hired by firms. If nominal demand rises beyond this point, say to y_{d1}, the rise is only reflected in price increases. Real output is unaffected as the short run maximum production capacity is fixed. In that situation, point A is obtained, where the short term supply curve runs vertically and real output is determined by supply factors only. Here the 'supply model' is said to apply, and the variable 'model' gets the value 1.

The computer must be 'guided' in choosing the correct point of intersection in each case, because each demand curve intersects twice with the supply curve: in a relevant part and in a irrelevant part.[10] y_{d1} in Diagram 3.2 intersects in A and in B, where the computer should choose A, and y_{d2} intersects in C and in D, where it should choose C. In both cases the maximum of the respective values obtained for P_y and the minimum of those for y are relevant. As a consequence, we can summarize the equilibrium in the goods market by equations (3.7) - (3.9):

$$P_y = \text{maximum of } \frac{Y}{cap} \text{ and } \frac{Y_L}{y} \tag{3.7}$$

where maximum production capacity, cap, is determined as

$$cap = \text{minimum of } \frac{1}{\kappa} k \text{ and } \frac{1}{\alpha} (\ell_s - \ell_g) \tag{3.8}$$

and

$$y = \frac{Y}{P_y} \tag{3.9}$$

where Y indicates nominal demand, see equation (2.20). Obviously, if 'model' = 0, y and cap coincide.

Section 2. Patterns of adjustment

Patterns of adjustment implied by this model[11] can be clarified with the help of Diagram 3.3.

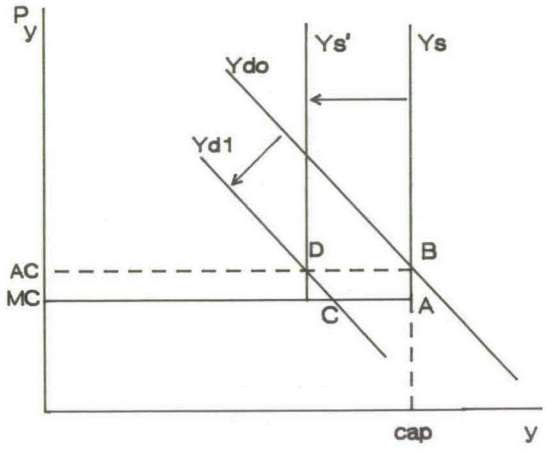

Diagram 3.3

To analyse the patterns of adjustment, a distinction is made between two cases: one where production capacity is limited by the amount of physical capital available, and one where capacity is limited by the number of people firms can attract. We will start with the former.

For didactic reasons a stationary starting position is preferable. Suppose the starting position is at B in Diagram 3.3, where the actual price P_y equals average production costs (AC). At B, production is at full capacity and profits are zero. This implies that net investments are zero (see equation (3.6) above). Therefore, other things being equal,[12] point B resembles such a stationary equilibrium.

If demand falls back to y_{d_1} (because of a decline in government expenditure, for example), supply drops to the level indicated by C, P_y (equal

to marginal costs -i.e., labour costs- as capital is fixed in the short run) falls short of the average production costs. The demand model is obtained and a loss is incurred. This will lead to net disinvestments. Consequently, production capacity will go down at given demand,[13] ultimately up to the point where D is reached. A new long run equilibrium is established, and the supply model applies again.

What will the adjustment process look like if the demand impulse is positive, assuming that capacity is still restricted by the amount of physical capital available? See Diagram 3.4.

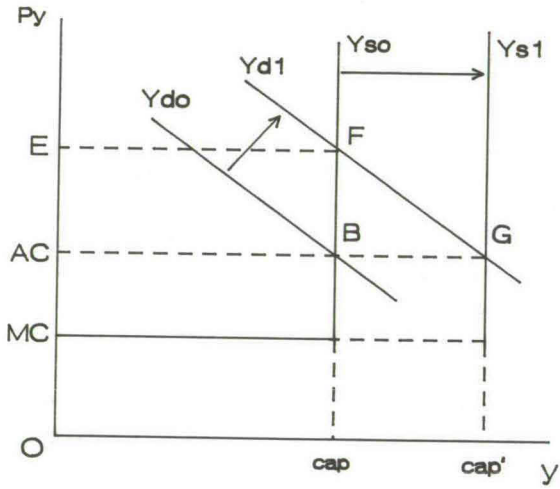

Diagram 3.4

B is the same starting position as in Diagram 3.3. Unemployment equals Q. Suppose demand is raised from y_{d_o} to y_{d_1}. Prices go up from AC to OE in order to clear the goods market, thereby causing positive profits. This invokes net investments and, after a delay of two periods, an increase in production capacity, causing prices to fall back to the point where they again equal average production costs at cap'. The new equilibrium is found at G.[14]

If labour rather than physical capital is the bottleneck for production expansion and the Phillips mechanism is left out of equation (2.14), a stationary situation (i.e., a long run equilibrium) can only exist if the sales value exceeds the sum of labour cost and the cost of machines actually in use. In other words, P_y should exceed the value it had in Diagram 3.4 where capital was the bottleneck. The reason is that if profits should be zero, the cost of capital not actually used is to be covered by the sales revenue, as well.

If prices fall short of this equilibrium level, say because of lower demand, losses are incurred and the stock of capital shrinks. It may even shrink to the extent that it determines 'cap' again (as above). If so, the adjustment process described above applies, and changes in real output are possible.

If prices exceed their equilibrium value, for example as a result of increased demand, following equation (3.6) net investments are obtained, which causes a growth in the stock of capital (although capital was already 'under-utilized') until losses (due to the growing underutilization) compensate the initial profits (that were caused by higher output prices). No changes in real output are obtained. It can be calculated that under our assumptions (see Section 3 below), if P_y equals 1.1, the stationary stock of capital would be about 141. This implies a production capacity of capital (if labour would be available) of 141 goods, which is overwhelming if compared with the production capacity of labour (103). This implies that the investment behaviour of entrepreneurs is rather rigid: they continuously expand the production capacity of machines, while the production capacity of labour has already been greatly exceeded.[15]

It can be concluded that without a Phillips mechanism a stationary starting position characterized by labour as the bottleneck for production expansion, although theoretically possible, seems rather unrealistic. Few entrepreneurs will regard underutilization of capital to be a real long term position.

If the Phillips mechanism **is** included, a situation characterized by full employment cannot be a long term equilibrium, not even in theory. Wages will rise each period, causing changes in demand and production

costs. For a long run equilibrium to be established, employment should be Ω less than 100% . In other words, a stationary starting position is then obtained only if production capacity is determined by the availability of physical capital.

The following conclusions can be drawn from this section.

1. If physical capital is the bottleneck for production expansion, the long term equilibrium is characterized by the equality between goods prices and average costs.[16] If a positive or negative impulse on demand is effectuated, prices in the short run will deviate from average production costs, where the minimum price level equals marginal production costs. In the short run changes in output will only occur if goods prices are at this minimum.
   In the longer run, however, if due to decreased demand, prices fall below average costs (implying net losses), net disinvestments are obtained, adapting supply to (decreased) demand, thereby leading to higher prices. If goods prices exceed average costs, production capacity will increase (through positive net investments), reducing prices again and, also in this case, adapting supply to (increased) demand.
   Hence, demand shocks will in the short run merely cause price changes, whereas in the long run supply in real terms will completely adapt to changed demand.
2. An initial starting position characterized by a production capacity limited by the availability of labour is not suitable. As such a situation can be obtained during a game, however, the model should be able to cope with it.
3. A demand model with prices equal to marginal costs cannot imply a long run equilibrium. In such a situation, losses are incurred causing divestments. The consequent smaller capital stock will result in higher output prices until the supply model is obtained.

Section 3 Illustrating the model: simulations

Introduction

We will begin this section by describing the starting position in Section 3A. Given an initially stationary economy,[17] all deviations from the starting values can be attributed to the use of instruments in the home country or abroad. Moreover, again for didactic reasons, we tried to create a starting position applicable to as many varieties of the model as possible. In the tables to follow, the values in period t = 1 resemble this starting position.

Next, in the same section, we will turn to the description of some main effects of various impulses in the current model when only a real sector is included. Out of the numerous possible combinations of impulses, we have for reasons of clarity chosen to describe effects over time of a few contrasting individual impulses in period t = 2.

While analyzing these effects we will concentrate on the main ones in periods two and three (and four, if necessary) as well as on the long run effects.[18]

Finally, in Section 3B, we will list some reasons why combining the present real sector with a monetary block as described in Chapter 2 would be undesirable. As a consequence, discussion of the starting positions in the monetary sphere is postponed to the next chapter (Chapter 4).

Section 3A Impulses without a monetary sector

The starting position

The starting position is based on point B in Diagram 3.3 above, with physical capital fully employed and the percentage of unemployed, u, equal to Ω (in order to get stationary wages if a Phillips mechanism would have been included).

To avoid net (dis)investments, profits (Y_R) should equal zero. This must mean that the government does not run a deficit.[19] Hence $Y_R = F = 0$.

We assume initial prices of goods and prices of gold (and as a consequence exchange rates) to equal one. Since with substitution we assume a macro-economic Cobb Douglas production function of the type $y = \beta_0 \ell_m^{\beta} k_v^{1-\beta}$ with β equal to 0.8, the price of capital (P_k) should amount to 0.2. Since $P_k = (r+\delta)P_y$ and for simplicity r = 0 if no monetary sector is assumed, the rate of depreciation, δ, must equal 0.2, implying that Θ, the life span of a machine, equals 5.

With ℓ_m and k_v equal to 100, to get private production of 100 goods with substitution (β_0=1) as well as with complementary factors of production (α=1 and κ=1), a 'δ' of 0.2 must be 'accompanied' by gross investments of 20 for k to be stationary. Since ℓ_m = 100 and P_L = 0.8, Y_L must equal 80.

If the government buys 4 goods (G=4), if its transfer payments (TRF) equal 20 (TRF=20) and its budget deficit is zero and if its import tariff revenue is zero because tariffs on imports are initially assumed zero, the labour tax rate should be 24% (on total household income of 100).

Consequently, net household income equals 76, equal to consumption of home produced goods (C) and imported goods (M), where C = 60 and M = 16.[20] This implies, $M_{ij} = 5\frac{1}{3} \cdot \varepsilon$ equals 0.08889.

'TRF = 20' implies $\ell_g.08 + \ell_u. 0.64 = 20.$[21] Assuming ℓ_g = 22 implies ℓ_u equals 3.75. Consequently, ℓ_s equals ($\ell_g + \ell_m$ (=100) + ℓ_u =) 125.75. So, u = 3.75/125.75 = 2.982107355.

In order to get stationary wages even with a Phillips effect, this should also be the magnitude of Ω.

Summarizing, the national accounts initially show the following picture if no monetary sector is included:

firms

$Y_L = 100 \times 0.8 =$	80	C	60
$\delta k\ P_y = 0.2 \times 100 \times 1 =$	20	G	4
$Y_R =$	0	I	20
		EX	16
	100		100

households

C	60	Y_L	80
M	16	TRF	20
B_T	0		
B_L	24		
	100		100

entrepreneurs

B_R	0	Y_R	0
	0		0

government

G	4	BL	24
TRF	20	BR	0
F	0	BT	0
	24		24

where goods prices and exchange rates equal one, wages equal 0.8, unemployment benefits are at 80% of wages (= 0.64), while the following values are taken as coefficients

$$\alpha = 1,\ \kappa = 1,\ \delta = 0.2,\ \varepsilon = 0.08889,\ \gamma = 0.1,\ \pi = 0,\ \Omega = 2.982107355$$

and initially

$$\bar{T}_L = 0.24,\ \bar{T}_{ij} = 0,\ \bar{T}_R = 0.6,\ \bar{\lambda}_g = 0,\ \bar{P}_L = 0,\ \bar{P}_{LCS} = 0,\ \bar{P}_{LU} = 0,\ \overline{ER} = 0$$

the rate of unemployment equals Ω and a system of fixed but adjustable exchange rates applies.

Finally, employment in firms (i.e., companies owned by entrepreneurs) is 100, while the amount of fixed capital available in the short run (100) is the bottleneck for production expansion: production capacity equals 100.

What happens to 'welfare' if no impulses are carried through, that is, if none of the players groups uses one or more tools of economic policy?

As stated earlier, in this model with no monetary sector, all economic variables will be constant over time. This is shown by Table 3a.1, where the main endogenous factors are listed if no policies are pursued.[22] The sole item changing is welfare, declining each year by about 0.25. Since private final absorption does not change and unemployment stays at 3 percent, these two factors cannot be a cause of that decline in welfare. The latter can, however, be attributed to the following factors:

1. inflation equals zero; this causes welfare to increase by + 0.25 each period,
2. the government budget balances; this leads to a further increase in welfare of + 0.25 each year,
3. the balance of payments is in equilibrium; since the optimal value of this surplus is 4, this will cause welfare to increase by $0.25 \times (1 - |-4|) = -0.75$.

Hence, total welfare will go down by 0.25 each round.

What will be the main effects if one or more countries manipulate their tools of economic policy?
We will successively describe the consequences of

a. a government expenditure increase ($\bar{g}$), fiscal policy;
b. a change in wages ($\bar{P}_L$), wage policy;
c. a change in profit tax rates ($\bar{T}_R$), supply-side policy.

We will analyze these impulses by subsequently assuming a multilateral action, and a unilateral action. In the latter case this analysis will first be done with a lagged influence of relative prices on the ratio between imports and consumption at home, then with an immediate dependency in this respect (both with fixed exchange rates) and finally combined with freely floating exchange rates. In the former situation (an identical intervention in all countries) the exchange rate system as well as the possible time lag in the import equation are irrelevant due to the equal-country assumption.

In Subsection d, the demand range, we will illustrate the pattern of adaptation if the economy moves into the demand range.

a. An increase in material government expenditures

Assumptions: no monetary sector, world-wide impulse.

Table 3a.2 gives the main results of a worldwide material government expenditure impulse of 10%[23] in period t = 2. (Column t = 1 provides the starting values).

In the impulse period, real government expenditure goes up. Given total output (capacity determines demand during all periods as indicated by 'model = 0'), this must mean that via price increases price sensitive private spending categories are crowded out. Since nominal net consumer income is fixed, a (world-wide) price increase reduces net real consumer income (w_B) and consumer spending in all countries. So, exports and consumption will shrink in real terms to allow for the increase in real government expenditures. The final spending category, investments, does not change: since last year's profits are zero, the higher price level does not influence the number of goods entrepreneurs can buy with those profits.

At given wages, the higher output prices result in an increase in profits, Y_R. This leads to more investments in period three. In the meantime, welfare (in t=2) is 0.25 lower than it would have been if no policies were pursued. This is due to lower private consumption, price instability (i.c. inflation) and an unbalanced government budget.

Increased investments in period three have two impacts:

- a spending effect: higher goods prices in t=3, and consequently a slightly lower consumption and exports level in that period. This spending effect can be regarded as a secondary impulse on aggregate demand.
- a capacity effect: production capacity in period 4 goes up from 100 to 100.084. The assumed complementarity between capital and labour ensures increased employment opportunities.

Since supply in the latter period grows, this leads to lower goods prices and therefore higher real spending opportunities for consumers and lower

(but still positive) profits. This in turn will lead to increased supply and employment, lower prices and profits, etc., in future.
Apart from a redistribution between private and public consumption, in the short run (t=2) no volume changes were to be reported, just nominal changes. In the long run (reproduced in the table by periods 100 and 101), however, prices return to their initial levels while output and final private as well as government absorption are at a higher level. The reason final private absorption goes up is that since employment grows, household income grows: unemployment benefits mount to 80% of wages. Thus private spending goes up, again leading to higher employment, etc.[24]

So in the long run, welfare exceeds the level it would have had if no policies were pursued, thanks to higher volumes (of production, private final absorption and employment). Note that if in the long run k is the bottleneck for production, hence $\dot{k} = \dot{y} = 0$, k (and y) can only be stationary if net investments are zero, i.e., if the ratio of investments over production equals δ. This holds for all tables when depicting a true long term situation.

Assumptions: no monetary sector, unilateral impulse, imports react slowly,[25] fixed exchange rates.
How does this concerted action (a world-wide government expenditure increase) compare to a unilateral action in this respect?

The main difference is that in the latter case prices in the respective countries no longer move simultaneously. Hence, the substitution effect in consumption decisions is added to the income-effect described above. Since the dependency of the ratio of imports to home consumption is lagged, this substitution effect will not have an impact before period three.

Didactically speaking, this 'splitting up' between an income effect and a substitution effect of price changes can be an advantage of a lagged reaction of imports to relative prices. A second advantage is the possibility it creates to illustrate the 'J-curve': as illustrated below, a price decrease of home produced goods, for example, instantaneously leads to more consumer spending, at home and abroad, i.e., imports go up,

thus causing the balance of payments to deteriorate. In the period thereafter, consumers will switch from imports to home produced goods which leads to a (on balance) positive balance of payments development.

The choice for a lagged influence of prices on imports also has a disadvantage, however. Since it introduces a J-curve into the model, on the short run the market for foreign exchange is unstable: a depreciation on the short run aggravates an excess demand for foreign exchange.[26] For the game this implies that the option for players to choose a system of flexible exchange rates no longer exists.

Table 3a.3 illustrates the main consequences of an unilateral increase in material government expenditures in country one (let us call this 'the home country' from now on). In the impulse period (period 2) consumption in real terms is crowded out by a production price increase in the home country. This price increase has a positive influence on profits in this country, inducing a capacity increase in period 4 (see below). Moreover, it causes the consumer price (price of final private absorption) to go up. This increase is attenuated however by declining prices of imported products (see below). Consumption as well as imports in real terms fall proportionally to the rise in the price level of (final private) absorption.[27]

Since our imports fall, exports by the rest of the world will decline. This implies a lower demand for the products of those countries, causing the prices of their products to fall. This explains the falling price of absorption abroad, and thereby the increased consumption and import opportunities, causing an increase in 'our' (country one's) exports.

In regard to the respective welfare developments, the balance of payments in country one goes up (caused by cheaper and fewer imports and increased exports in volume but especially in price, inverse J-curve, see above) which benefits our welfare. But this effect is more than compensated for by

- a shortage in the government budget, resulting from the impulse
- lower private (final) absorption
- a relatively high degree of price instability.

This causes welfare to be lower than it would have been if no policy action was taken. In the other countries welfare is (only marginally) declining when compared with that same "no intervention strategy" due to increased private absorption on the one hand, but, on the other:

- a slight price instability,
- a (marginally) unbalanced government budget (the governments in those countries run a surplus caused by lower prices for their purchases), and
- an unfavourable development of their balances of payments.

Comparison of these respective welfare developments illustrates that this hypothetical four-country world is an intermediate of the traditional small country assumption (where one country cannot influence the economies in the rest of the world) and the (less traditional) two-country world assumption, where country one can substantially influence the rest of the world.

As a result of the deteriorated competitive position of last year, in period three exports in country one drop and imports rise (the substitution effect). Consequently, the balance of payments of country one becomes negative. The drop in exports causes the production price in country one to fall,[28] thereby reducing profits. The fall in production prices is attenuated, however, by increased investment demand this period, due to positive net profits in the previous year. Although falling production prices do erode profits, the latter are still positive, causing a further capacity increase in period 5.

As a result of the increased import demand by country one, exports in the outside world increase. This causes higher production prices and positive profits. The increased exports can be regarded as the 'leaking away' of the spending impulse in country one. Given supply, they leave less room for consumer expenditures (in volume), implying a slight reduction of private (final) absorption, which is effectuated by higher production prices. On the other hand, these higher prices cause higher profits which guarantees that production capacity in the outside world will also start to grow (in period 5), after an initial decline in period 4.

In period 4 country one's production capacity increases. Capacity changes cet. par. have adverse production price effects. As a consequence,

in country one those prices fall, leading to lower profits, a (smaller) capacity expansion, etc. This process of decreasing production prices, profits and production (capacity) expansion continues throughout until the balance between prices and costs is restored.
In the long run, due to the fact that the impulse partly "leaks away", countries one and two develop alike, albeit that apart from exports the volumes in country one have grown faster than in the outside world. For the latter reason, the home country runs a deficit on the balance of payments (with a deficit on the government account equal to its counterpart), whereas the other countries run surpluses in these respects.

A comparison of these long run results with the 'concerted' action in the previous table shows that for country one the latter is only slightly less stimulating with regard to its own production and employment. The difference equals the degree to which production and employment elsewhere are stimulated. On balance, however, the outside countries suffer a welfare loss in period 100 which is mainly due to the incurred price instability in the short run. But since prices are stable in the long run, welfare will increase in those countries after a few more periods, too.

Assumptions: no monetary sector, unilateral impulse, imports react immediately, fixed exchange rates
If the time lag in the import equation (2.12) is dropped, the long run effects of a unilateral increase in material government expenditures as discussed above are not affected, contrary to the short run effects. Compare the present table (Table 3a.4) with the previous one. A major difference in the short run can be attributed to the fact that as imports react immediately now, the same must of course hold for exports. Consequently, given a government expenditure impulse, both consumption and exports will be forced down to the extent of the impulse. Therefore, private consumption will now be crowded out to a lesser degree than if exports had not helped to clear the goods market. Exports fall to the extent of the output price increase, as demonstrated in Appendix 2.2.

By the same token, in periods two and three, the price increase of country one's product will not influence imports, neither in volume nor in

price (whereas in Table 3a.3 imports declined in volume as well as in price in period two).

Table 3a.4 also illustrates that in the outside world, opposite effects occur: since imports out of country one become more expensive (due to the impulse), the substitution effect gives rise to more consumption of home products at the expense of those imports. On the other hand, the same increased import prices will make the consumer price index go up, decreasing the demand for those home products to the same extent. On balance, consumption will stay at the previous level, both in periods two and three. Since exports in volume are also constant (see above), total demand remains fixed, leaving product prices in those countries unaffected.

This gives rise to a further difference when compared to the case of a lagged influence of relative prices on imports: since product prices are fixed in the short run (just like production costs), profits in the outside world will remain zero (whereas in Table 3a.3 they declined in period two, and improved in period three.) Capacity changes will therefore not occur -given the lagged response to profits of two periods- until period 6.[29]

The fact that, albeit late, the production sector in this outside world is affected can be attributed to capacity -and thus employment and income- changes in country one that occur in period 4. The higher profits generated in period 2 will affect Y_L in period 4. This implies that from this period onwards the derivation given in Appendix 2.2 (of imports solely depending on their own price level) no longer holds: the increased employment opportunities will increase demand both at home and abroad. This also accounts for the fact that from period 4 onwards, country one will experience a shortage on its balance of payments for a number of periods.

Overall, however, a pattern of adjustment similar to that of imports determined by lagged prices can be observed: higher prices in country one will on the one hand increase profits, capacity and employment and thereby -on the other hand- also increase import demand in the outside world (the "leaking away" process) invoking the same sequence there. Higher capacity will lead to lower prices, and thus the reversed chain in the longer run.

Welfare developments in the respective countries in the longer run are comparable to the ones given in Table 3a.3.[30]

Assumptions: no monetary sector, unilateral impulse, imports react immediately, flexible exchange rates

The results produced in Table 3a.4 can also be compared to the main effects of a similar impulse under the regime of (world-wide) freely floating exchange rates. With capital internationally immobile in the traditional Mundell-Fleming framework fiscal policy is more effective if exchange rates are free, due to the invoked higher export demand caused by a depreciation of the home currency.

The main results concerned here are given in Table 3a.5. In our case -the case of a 'supply model'- such an exchange rate regime more suitable for expansionary fiscal policy should show a higher price increase (due to increasing exports caused by the depreciation), hence higher profits and thus a higher increase in production capacity.

Comparing Tables 3a.4. and 3a.5 shows that this is indeed the case, albeit to a minor extent.

In periods two and three, exchange rates do not fluctuate. This can be explained along the lines followed above: the product price increase in country one in t=2 does not change import demand -neither in volume nor in price- and the relative decline in exports (volume) equals the percentage rise in product prices. Since, as a consequence, neither the value of exports in home currency, nor the value of imports in foreign currency changes, their ratio (the exchange rate) should be constant as well.

In period 4, the increased labour income that gave rise to a deficit on the balance of payments in country one if fixed exchange rates were maintained will now ensure a depreciation of the home currency: $ER_{1j}(j=2,3,4)$ goes up. Since in the rest of the world such an income effect on import demand does not "yet" exist,[31] the value of their import demand (that is country one's export value) does not change. Hence, the depreciation in Table 3a.5 equals the percentage rise in import value in country one that would have occurred if exchange rates had been fixed (see Table 3a.4).

Since the depreciation is obtained to offset the increased nominal import demand by country one in currency two, that import demand in volume will never change. As a consequence, product prices in the rest of the world will be constant in all periods. And thus, even stronger, nothing in the production structure of the rest of the world will change. Consequently, the rest of the world will not benefit (in the sense of an increase in demand) from a government expenditure impulse in country one, contrary to the case of fixed exchange rates. The only consequence in the other countries will be a slightly higher demand for imports from country one (due to the appreciation of their currency) and a fluctuating consumer price level. Initially, this consumer price goes up (imported inflation); later, given the gradual return to initial product prices in country 1, a lower consumer price results (due to the appreciation).
In real terms the flexible exchange rates in this version insulate outside countries, both in the short and in the long run.

The results presented above relate to a typically demand-oriented instrument. Most impulses open to players here are demand-oriented. Given the exogenous character of real government expenditures, the results of manipulation of the tax rate on labour income, for example, can largely be explained along the lines followed above.

While a typically supply-oriented instrument, a change in the tax rate on profits, will be discussed in Subsection c, we will now look briefly at the main results of a 'mixed' impulse: a policy-induced change in wage rates.

b. A change in wages [32]

Assumptions: no monetary sector, world-wide impulse.
Again a wage impulse[33] can be either a unilateral action or an action pursued world-wide.[34] We will start by describing the main results of the latter, as reproduced in Table 3a.6
The only thing really happening in this table is that in the impulse period (t=2) all wages and prices are increased by 10%, the magnitude of the impulse. The reason is straightforward: output prices and costs are increased (in all countries) to the same extent, leaving no room for

profits to emerge. The reason output prices go up by 10% is that consumption and exports should in volume be constant (supply-model). Since relative prices are constant, a substitution effect on exports or imports cannot be expected. Furthermore, since the impulse raises nominal wage income by 10%, real consumption can only be constant (given $\dot{P}_y = \dot{P}_m = \dot{P}$) if prices are increased to the same extent.

The only thing left is this world-wide price increase to the extent of the impulse (and consequently a welfare decline). This can be illustrated by means of Diagram 3.5.

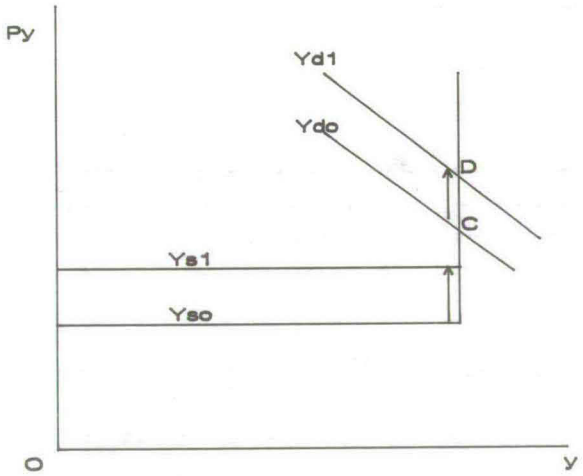

Diagram 3.5

Initially the economy is at C with output prices equal to average costs. Increasing P_L causes the demand curve to shift upward (to the right) proportionally. Since the economies are at full capacity, however, this will cause prices to go up until D is reached.[35] So all costs and revenues out of sales have gone up by the same amount, implying constant (zero) profits.

Far more interesting, analytically speaking, is a similar but unilateral action: $\bar{P}_{L_1}$ = +10% in t=2.

Assumptions: no monetary sector, unilateral impulse, imports react slowly, fixed exchange rates.

See Table 3a.7. The increase in the price of final private absorption (P) in country one in period 2 will be "about" 10% (see below). This ensures a constant real labour income and therefore a constant demand (in real terms) for country one's products, equal to full capacity output. Private consumption of home products (c) does not change and (since m/c should still be constant) neither does the demand for imported products - both in real terms. Since in the outside world products imported from country one become more expensive, real wage rates fall which results in less consumer spending. To compensate for this development, product prices must fall, leaving c (and thus m) unchanged.

Lower product prices in the outside world imply lower import prices (P_m) in country one. For the average of P_y and P_m in country one (P1) to go up by 10% as discussed above, product prices in that country should rise by more than 10%,[36] in this case by about 13%. This leaves room for profits to reach a positive value, whereas in the outside world, due to the price fall, they become negative.

So, given the conditions of the supply model -where initially output and all components of demand are fixed in real terms- an (unilateral) increase in wages leads to an increase in profits. A drop in wages would have led to net losses.

Instantaneously, country one's balance of payments will show a surplus: with volumes unchanged -as discussed above- this balance will be determined by increased export prices and decreased import prices (J-curve). This will attenuate the fall in welfare in country one caused by the invoked consumer price increase and the unbalanced government budget. The outside countries will experience a sharper fall in their welfare levels mainly due to a shortage on their trade account.

In period three a substantial switch between consumption in country one and consumption elsewhere (in favour of the latter) takes place. Exports by country one shrink, while those out of the other countries are boosted.

This is caused by the deteriorated competitive position of country one in the period before. The respective imports show a reverse trend.

As a result of this fall in demand for country one's products, product prices will fall, giving rise to an on balance increased consumption volume. The remainder of the gap (caused by falling exports) is filled by increasing investments made possible by positive net profits in period two. The average consumer price level in country one will fall - an outcome of falling prices of home products and increased prices of imported goods. The latter development is caused by the switch in expenditures.

Profits in country one sharply decrease (and in fact become negative) as a consequence of declining product prices. This will more than offset the positive investment developments in this period, described above: in the long run the capital stock in country one (k_1) will decrease, while in the rest of the world it will show an expansion (caused by the switch in demand described above).

Since in this case k determines the output actually produced, the respective output volumes will show equivalent developments. Unemployment in country one will, as a consequence, show a sharp increase, whereas in the other countries it will fall. Also in the long run, the distribution of output over the respective spending categories in country one will change: fewer exports (due to higher product prices) will facilitate relatively more consumption (although employment falls this is made possible by higher wages), both in real terms. Exports in the 'outside countries' go up. Thanks to increased employment opportunities, the same holds for consumption, albeit to a mild extent. Note that in the long run output prices in country one have increased by the percentage of the wage impulse, whereas in the other countries they returned to their initial value.

This leads us to the conclusion that labour in country one hardly benefits in the long run from the 10% wage impulse in period two: total (private final) absorption goes up by less than 1.8%, whereas unemployment increases by about 50%. In the outside world, that absorption falls by about 0.5%, whereas unemployment declines by about 20%. So, given the assumptions, wage policy is hardly more than an expenditure switching device on the long run. Moreover, price instability in country one has

greatly exceeded its counterpart in the outside world. Since, finally, country one experiences a deficit on its balance of payments (reflecting the surplus of the other countries) due to increased absorption with lowered production, and a relatively large imbalance in the government budget, welfare in country one is seriously hampered when compared with welfare outside and when compared to the situation of no-intervention.

Assumptions: no monetary sector, unilateral impulse, imports react immediately, fixed exchange rates

The main results under these conditions are shown in Table 3a.8. Again, in the long run this table is virtually identical to Table 3a.7, but this does not hold for the short run. Owing to the immediate switch to products produced outside country one, as early as period two a shortage on country one's balance of payments emerges.

Since falling exports (in volume) leaves a gap in total production to be filled by increased consumption, the rise in the price level of private final absorption in country one will be lower than in Table 3a.7. Since the output price increases by less than 10%, net losses will be experienced immediately. In the outside world increased demand by country one's consumers will force product prices to go up, resulting in profits. Hence, the effects occurring in period three in Table 3a.7 now show up -in a qualitative sense- in the impulse period. Also, the J-curve effect no longer appears. On the other hand, in the short run Table 3a.8 shows a substantially less oscillating pattern.

Assumptions: no monetary sector, unilateral impulse, imports react immediately, flexible exchange rates

See Table 3a.9. Apart from exchange rate changes, the only thing happening is that product prices and costs increase to the same extent, leaving profits unaffected.

The reason this is obtained is very closely linked to the result derived in Appendix 2.2:

$$\dot{m} = -\dot{P}_m \text{ , or } (\dot{\overline{m\ P_m}}) = 0$$

as long as household income is unaffected. In other words: under this assumption imports do not depend on prices of home products. If nominal

wage rates are enhanced, this will, apart from possible substitution effects, cause a proportionate increase in imports (and home consumption), provided the price index is constant. As a result, product prices abroad will go up. In turn, this will lead to a decline in imports proportionate to the price increase abroad, but this substitution effect as such will not alter the value of imports.

The remaining deficit on country one's balance of payments will cause its currency to depreciate. This causes the volume of its imports to go down proportionally. Since the volume of imports initially went up by the percentage of the wage impulse (10%), the depreciation -forcing this volume to fall back to its original value again- should be 10% as well.

As a consequence, the price of imported products denoted in country one's currency will go up by 10%. The wage impulse initially enhanced the demand for home products (and imports) proportionally. Given the restrictions on supply, prices of these products will go up, again to the same extent.[37] This way $\dot{P}_m = \dot{P}_y = \dot{P}$.[38] This explains why in real terms nothing changes (and in nominal terms, only in the first period) if, with flexible exchange rates, one country increases its wage rate.

c. A change in profit tax rates

Let us now turn to the analysis of a typically supply-oriented impulse and let us assume a reduction in period two in the tax rate on profits ($\bar{T}_R$).

Assumptions: no monetary sector, unilateral impulse, imports react immediately, flexible exchange rates

If this were the only impulse, given the absence of a monetary sector, the respective economies would not diverge from their original starting position. The reason is that initially profits were assumed to be zero, so a change in the tax rate on those profits would change neither net profits nor tax receipts.

Therefore, let us assume a profit tax rate reduction in country one (from 0.6 to 0.5 in period two, leaving it at that level for all subsequent periods) in combination with an impulse generating profits in that country: an increase in material government expenditures of 10% under the assumption of flexible exchange rates. The latter impulse was described

above in Section a (Table 3a.5). The differences between that table and the one to be discussed here (Table 3a.10) can therefore be attributed to the profit tax reduction.

Since all expenditures out of profits (investments and tax payments) were assumed to be lagged, period two shows the same picture as before - that is, without tax rate reduction.

In period three those expenditures increase. Since investments go up, other private spending categories will be suppressed further than before, by a larger price increase (c and x fall more sharply). Product prices rise faster, constituting an extra impetus to net profits. Consequently, capacity expansion (and therefore employment increase) from period 4 onwards will be larger than without the profit tax decrease.

As entrepreneurial tax payments fall, on the short run the government deficit increases if compared to the situation without tax reduction. However, in subsequent periods the government budget is positively influenced.[39] In the long run, however, all differences with Table 3a.5 disappear.

The general picture that shows up can readily be understood if one recalls the adjustment mechanism described in the preceding section of this chapter. This mechanism boils down to capacity adjusting to demand shocks (via influences on product prices, profits and investments, respectively). A decrease in the taxation rate on profits has virtually the same impact as a higher response of investments (that is capacity-changes) to profits. The effect is a higher oscillation of economic variables around their trend values. In other words, the upswings are higher, the downswings are deeper, but the new long term values are not changed by an alteration of the tax rate on profits.

d. The demand range

Assumptions: no monetary sector, world-wide increase in the labour tax rate.

The impulses described so far all showed a clear persistency of the economies to stay in the "supply-model-range": the variable 'model' kept its

initial value of zero during all periods. This feature was also typical when this version of the game was actually played. Nevertheless, it is surely possible to get the model in the 'demand-range', the range where goods prices are determined by costs and the volume actually produced is determined by demand. In this range capacity will, however, react quickly so that the model will return to the supply range.

This can be illustrated with the help of Table 3a.11, where the tax rate on labour income is increased rather drastically (by 20% - points from 24% to 44%) in period two in all countries. The dramatic fall in consumer demand will make the model switch to the demand-range immediately. Output prices drop to the level of P_L (= 0.8) and will stay there until capacity has adapted sufficiently (period 6). The latter shrinks, due to a fall in profits attributable to lower output prices. The welfare level is affected rather unfavourably: prices vary sharply during the adjustment process and employment opportunities fall dramatically. Especially after the impulse period, the imbalance of the government budget remains remarkably low when compared to the magnitude of the impulse. This can be explained by the increasing number of unemployment benefits.[40]

Section 3B Combining the present model with the monetary block

Formally, it is possible to combine the model used in this chapter with an explicit monetary sector as described in the final part of Chapter 2. We will start out this section by demonstrating that the combination of the investment equation (based on past profits) and a bonds market with everlasting securities can in some circumstances produce 'perverse' results. (Moreover, the influence of monetary disturbances on investment behaviour is very weak - see below.) As a consequence, this combination should not be recommended to future game leaders. This constitutes a further argument for an alternative investment equation not leading to those 'unorthodox' results (see next chapter).

The basic feature of the monetary sector producing the possible absence of real effects of monetary policy or its perverse results mentioned[41] is the assumption that depreciation allowances are invested in bonds.[42]

Suppose that in this model and with a stationary real sector, the interest rate on bonds goes up, due to a contractionary monetary impulse. This will imply on the one hand that the new investments (equal to 20) are financed at a higher rate of interest. On the other hand, depreciation allowances bear that same higher rate of interest. Consequently, profits will not change and therefore investments will not be influenced by this monetary policy.[43]
This clear dichotomy in the case of a stationary economy between the real and the monetary sector is demonstrated by Table 3b.1 below. In that table the effects of a contractionary monetary policy (MP = -5% for all countries) in period two are given.[44] The interest rate does indeed rise, as expected, but the real sector is not influenced.

This does, however, not justify the above statement of possible "perverse" results. These perverse implications will occur in the situation where, before the monetary policy entrepreneurs experience losses and a contractionary monetary policy is pursued. In that situation, before the monetary impulse, the value of depreciation allowances is higher than that of investments: net losses lead to net disinvestments. As depreciation allowances were assumed to be invested in bonds and investments in fixed capital were supposed to be financed externally, in such a situation firms on balance invest in bonds. If the government raises the interest rate (the monetary policy), the increase in financing charges (due to externally financed investments) will in absolute terms be smaller than the increase in interest proceeds (out of invested depreciation allowances). Consequently, due to the contractionary monetary policy, profits will go up, leading to more (as opposed to less) investments.
Analogously, if in that same initial situation (net losses), the government decided to follow an expansionary monetary policy, firm interest proceeds would fall more sharply than interest payments. Hence, realized losses would increase and as a consequence investments would go down rather than up.

This is illustrated in Tables 3b.2 and 3b.3. In the first table the main results of a government expenditure reduction and a monetary contraction (G = -10% and MP = -5% in all countries) in period two are presented.[45] In Table 3b.3 under the same assumptions (among others, a

life span of 10 periods[46]) the main effects of solely a decrease in material government expenditures are shown. Comparison of the two tables tells us that contractionary monetary policy is indeed expansionary with regard to investments.

A final, more practical reason not to combine this version of the real sector with the monetary sector is the small extent to which monetary impulses influence investment behaviour (if they do have an influence at all - see above). This 'marginal' influence is illustrated by the comparison of Tables 3b.2 and 3b.3. The reason is that profits made last year (determining investments) are a product of all machines in use. If interest rates rise, only the latest addition (i.e., new machines) will be financed more expensively. Consequently, total profits (and thus future investments) will hardly change. This characteristic provides a further argument to switch to an alternative investment function, e.g., the one to be presented in the next chapter.

Especially the possible perverse influences of monetary policy provide a didactic argument to use the model discussed in the present chapter with a real sector only. If used this way, the game may not only help students to understand the behaviour of the equations involved, but it may also serve as a 'step-up' to other, more complex versions of the game, for example those that are suited to include a monetary sector like the one used in Chapter 4.

NOTES (Chapter 3)

1 In this chapter, when we speak of capital, we are referring to physical capital goods, unless otherwise indicated.

2 Richard W. Kopcke, "The Determinants of Investment Spending", New England Economic Review, July/August 1985, pp.19 - 35.

3 See E.M. Claassen, "Grundlagen der Makroökonomische Theorie", 1980, p.69.

4 F. Scotland, "Investment: A Survey of Models with Some Implications for the Effects of Monetary Policy", Technical Report 29, Bank of Canada, Dec. 1981.

5 As will be remembered from Chapter 2, depreciation allowances received by firms are invested in bonds. With autonomous investments (as all fixed investments financed externally) equal in size to depreciation, in a stationary economy (i.e., if net fixed investments are zero and gross investments equal depreciation) firm bond supply equals firm bond demand.

6 Technically, the lag is necessary to prevent simultaneity between investments and their determinant.
Our specification is for example in compliance with an empirical Dutch study by Tjan, who approaches expected profitability, a determinant of investments, by past profits and assumes a lag between the decision to invest and the actual purchase of investment goods. See H.S. Tjan, "Rendement, interestvoet, bezettingsgraad en investeringen", Centraal Planbureau Overdrukken-Reprints, no. 185, CPB, 1985, p.5.

7 Dale W.Jorgenson, in American Economic Review, vol. 53, May 1963, "Topics in Economic Theory", pp.247-259. Scotland: same reference as before.

8 If this part of investments should keep the capital stock constant if no net investments are undertaken, theoretically it should equal the investments of $\theta + 1$ periods ago. To prevent an 'echo-effect', we will stick to the assumption in the main text.

9 In an equilibrium point, y can refer to real demand as well as to real supply (both regarding firm output). y_s relates to supply only, y_d relates to demand only. In diagrams for technical reasons sometimes capitals are used for these respective symbols.

10 Technically, the computer model contains two supply curves. One is horizontal and the other is vertical; only one of them is relevant.

11 In this section, we will leave the monetary sector aside. The reason is that - as will be discussed in Section 3B of this chapter - the combination of the monetary block described in Chapter 2 with the present investment equation can lead to 'perverse' results.

12 One of the variables that should stay at their starting level in order to qualify B as a stationary equilibrium is the wage rate. If in B,

u would be unequal to Ω and a Phillips mechanism would apply, wages would change (see eq. (2.14)). Consequently, in the starting position u equals Ω. It can be shown that activation of this Phillips mechanism does not always increase the chances of stability. Hence, in order not to let the game die a premature death, this effect should be moderate. Moreover, it can be shown that for stability purposes ε should be high enough, once the Phillips mechanism is introduced. It is repeated that for the sake of simplicity we leave this mechanism out in the remainder of this dissertation unless otherwise indicated.

13 Obviously, generally speaking, demand will not remain constant (for instance, as a result of the decline in demand for investment purposes). We postpone discussion of this process to Section 3 below.

14 For the sake of simplicity, it is assumed here that the demand curve would remain at y_{d_1}.

15 This is one of the reasons why we regard the alternative investment function - based on expected profitability of new capital goods - as preferable. See Chapter 4.

16 If the Phillips mechanism is incorporated, in the long run unemployment must be such that the influence of this mechanism on wages is zero (i.e., $u = \Omega$). If it is positive ($u < \Omega$), production costs will rise, which at given prices implies losses, net disinvestments, lower production capacity and higher unemployment, until $u = \Omega$. The reverse holds if $u > \Omega$.

17 If a monetary sector is included in the model, this is only possible for the real sector. See Chapter 4.

18 We sometimes speak of 'years' when we mean 'periods'. Of course the length of a period in the model does not necessarily coincide with that of a year. Unless otherwise indicated, the long run position is given by the last two columns in a table. The reader is reminded that Chapter 7 summarizes the effects under all alternative assumptions of fiscal policy, wage policy, profit tax policy and monetary policy.

19 In four identical economies the balance of payments should equal zero initially. This implies zero net national savings. Consequently, if profits are to be zero, private savings are nil and net government savings should be zero as well. See Kalecki's law.

20 Since all countries are identical in the starting period, exports should equal imports initially.

21 Assuming that civil servants' salary equals wages in the market sector, while the unemployed get 80% thereof.

22 Table 3a.1 and all other tables are calculated by the computer using the Powell method.

23 10% of an initial value of 4 implies an impulse of 0.40 on initial total purchases with firms of 100. This indicates that a 10% impulse on

G - the maximum admitted to players in the game - is in that sense a relatively small one. When we speak of "an impulse of 10%", we mean an impulse bringing G to a higher level in period 2 and leaving it there for the remainder of the periods analysed.

24 In the long run due to fewer unemployment benefits the initial government deficit, apart from rounding errors, disappears.

25 'Imports react slowly' indicates that a time lag is assumed in equation (2.12), the relationship between the m/c ratio and relative import prices.

26 Since imports make up only a small fraction of total private consumption, the impact of increasing import prices (deteriorating BB) exceeds the income effect on volumes traded, x and m (improving BB).

27 Since c and m both drop by $\dot{P}$ and $\dot{P}_y > \dot{P} (> \dot{P}_m)$, nominal consumption (of home produced goods) will actually increase.

28 The respective movements in production prices reinforce the unfavourable balance of payments development for country one.

29 Table 3a.4 suggests a fixed capital volume until period 7, but given the small change in investments in period 5, the seemingly constant capital volume in period 6 is due to rounding.

30 A difference, however, is found abroad. Owing to more short run price stability (see above), welfare on balance now increases.

31 Which can be verified by inspection of "k" in Table 3a.4 in period t=4.

32 As may be remembered from Chapter 2, if the wage rate paid in the private sector changes, the pay of civil servants and the unemployment benefits will automatically be raised proportionally.

33 Wages are calculated as the wages that would have applied if no action was undertaken in this respect plus an amount equal to the impulse-percentage times last period's wages. If wages are increased this way in period t and no further developments take place, they will remain at this level for all periods > t.

34 The intermediate possibilities (of two or three countries increasing their wages) are not discussed here.

35 In D all production costs have gone up by 10%. This also holds for capital costs since they equal, per unit, $P_k = \delta P_y$.

36 Given the lagged response of m/c to relative prices, a 10% nominal wage increase should be compensated for by a more than 10% increase in the price of final private absorption in order to leave c and m (both in volume) unaffected. This can be shown as follows:

$$P \equiv \frac{c.P_y}{c.P_y + m\,P_m} P_y + \frac{m.P_m}{c\,P_y + m\,P_m} P_m \,, \quad \text{hence } P = \frac{c\,P_y + m\,P_m}{c + m\,P_m/P_y}$$

Since c and m should be constant (see main text), and since the numerator increases by 10% (the nominal wage increase) while the denominator goes down (the ratio (P_m/P_y) decreases), the price index, P, rises by more than 10%. This second order effect has a consequence that, in order to keep real consumption constant, real labour income - measured as nominal income over the (final private) absorption price level - should in fact decrease. See w_B in Table 3a.7.

37 In foreign currency, due to the depreciation, country one's products are equally expensive, leaving volume and the price of exports unaffected.

38 Since real household income and profits on balance do not change, the picture remains unaffected after t=3.

39 This result can be compared to what is generally known as the 'Laffer curve'.

40 To be sure, in the game it is possible that in some countries the demand model applies, while in others the supply version obtains.

41 If combined with an investment function of the type $i = f(..,Y_{R_{-1}})$.

42 As the reader will recall, this assumption was necessary to produce constant (zero) profits if the (externally financed) investments equalled depreciation (and hence over time a constant k resulted).

43 Neither will they be influenced by expansionary monetary policy.

44 The model used here assumes no international capital mobility, a life span of 10 periods, and import reacting to changes in relative prices with a lag of one period.

45 Under the same assumptions of Table 3b.1.

46 Instead of 5; the difference is a result of the inclusion of a monetary sector. See Chapter 4.

Chapter 4 Complementary factors of production, investments determined by calculated rate of return

Section 1. Introduction

At the end of Chapter 3 several disadvantages were given of combining the investment function used in that chapter with the monetary sector. In that same chapter some peculiarities of the investment equation as such were given.

In the current chapter an alternative formulation for expected profits, the determinant of investments, is developed (Section 2). The subsequent section compares the present investment behaviour and the one assumed in the previous chapter.

To find out how the model reacts to this alternative specification, some impulses are analysed (Section 4). First, in Section 4A, the analysis pertains to a model only containing (explicitly) a real sector. In the subsequent sections a monetary sector is also included. Here a distinction will be made between the situation where capital is (internationally) immobile (Section 4B) and the one where capital is mobile (Section 4C).

Section 2. Derivation of the investment equation

Central to the present investment hypothesis is the idea that investors will not look at realized profits to get an idea of what future profits will be -as in Chapter 3- but that they will try to estimate the extra profits that will emerge from a possible investment.[1] If estimated profits are positive, entrepreneurs are assumed to expand on their capital stock. If they are negative, the stock of physical capital will shrink.[2]

When deciding upon net investment in period t, expected prices of output and factors of production in period t+2 are of interest: period t+2 is the period where those new investments will be in operation. First, we assume a time lag of one period between the decision to invest (i_D) and the actual purchase of the capital good (as discussed in Chapter 3); second,

there is an equal time lag between purchase and actual installation (see Chapter 2).

As 'our' entrepreneurs act under conditions of perfect competition, those prices of output and factors of production are given. At these (expected) prices he can supply as many goods as he wants to, and he can hire or buy as many factors of production as needed, exceptions disregarded (see below). Knowing this, the net present value of the expected gains (in money terms) from an expansion of the stock of capital by one unit, labelled "NP^e", can be calculated as

$$NP^e = \left[\frac{1}{\kappa} \times (P^e_y - \alpha P^e_L) - \delta P^e_y - r P^e_{y_{t+1}}\right] \times \frac{(1-\bar{T}_R)}{(1+(1-\bar{T}_R) * r)^2} \qquad (4.1)$$

The expected costs and benefits of an investment of one machine (read: physical capital good) in its first year of operation are summed on the right hand side of (4.1), where all expected variables relate to period t+2, unless otherwise indicated.[3] The respective terms and factors are explained as follows.

Given κ, the machine will produce $\frac{1}{\kappa}$ goods. Per product the positive difference between expected output prices and labour costs equals $P^e_y - \alpha P^e_L$. This gives rise to the first term on the right hand side of (4.1). The way expected prices of products and factors of production are calculated is dealt with below.

The second term in (4.1) represents depreciation costs: per period an equal percentage (equal to δ) of the machine valued at replacement value (P^e_y)[4] is depreciated.

The third term in (4.1) indicates other financing charges: interest payments. Since a machine is actually bought and financed externally in period t + 1, in each subsequent period expected interest charges mount to $r \times P^e_{y_{t+1}}$.

So far, (4.1) gives an indication of gross expected profits of an investment of one machine. To make this "after tax profits", the first three terms have to be multiplied by $(1-\bar{T}_R)$.

Finally, to get present terms, the expression has to be divided by 1 + the discount factor (the net interest rate[5]) using as an exponent the

number of periods between the present one and the one in which the profit is expected to occur, equal to two.

NP^e being determined, the hypothesis with regard to net investment decisions, i_D, if supply of labour is ample, reads as

$$i_D = q \frac{k^e}{y^e} \left(\frac{NP^e}{PV(P^e_{y_{t+1}})} \right) \qquad (4.2)$$

In (4.2) the denominator of the bracketed term, $PV(P^e_{y_{t+1}})$, represents the present value of the expected price of a machine when bought (one period ahead). It functions as the deflator for nominal expected returns to get a rate of return.[6]
The bracketed factor is multiplied by k^e/y^e. If the number of machines available is the expected bottleneck for production, this factor equals one. If, however, capital is expected to be abundant, the factor becomes larger than one. In this case -and labour still being ample (see below)- this situation refers to the demand model, with P^e_y below average costs (in expected terms). Therefore, NP^e will typically be negative here, causing net disinvestments. To make sure these disinvestments are larger if the expected degree of underutilization of capital is higher, the net present expected rate of return is multiplied by the reverse of the expected degree of utilization of capital.[7] The outcome, after multiplication by the reaction coefficient q, gives net (dis)investments. The way this coefficient is set is discussed in conjunction with Table 4a.2 below.

As stated, (4.2) holds as long as the supply of labour is ample. If labour is expected to be scarce, however, entrepreneurs will not expand the number of machines since the extra labour needed to handle these machines will not be available. In that case, we assume they will only be able to keep the labour hired so far, and thus will only make up for the depreciation factor.

In other words:

$$\text{if} \quad \frac{NP^e}{PV(P^e_{y_{t+1}})} > 0$$

$$\text{and} \quad \alpha y^e > \ell^e_{mmax}$$

$$\text{then} \quad i_D = 0 \qquad (4.3)$$

else (4.2) holds.

In (4.3) ℓ^e_{mmax} represents the amount of labour expected to be available for the private sector two periods after the decision on net investment is taken. It equals total expected labour supply minus the expected number of civil servants, see below.

Net investment decisions as determined by (4.2) and (4.3) lead to actual investments one period later. When added to depreciation, δk, it results in total (gross) investments, i:

$$i = i_{D_{-1}} + \delta k \qquad (4.4)$$

In (4.1)-(4.4), as throughout Chapters 3 and 4, both α and κ are fixed at 1. Moreover, if no monetary sector is included, the interest rate is for the sake of simplicity set at 0.

For the decision making process, the entrepreneur needs information on a number of macro-economic figures for t + 1 and t + 2. Output prices, wages rates, macro-economic output and the national capital stock are parameters which influence his micro-economic investment decision. The variables expected for t + 1 and t + 2 included in (4.1)-(4.4) are calculated as follows. As stated in Chapter 2, Subsection 2.1.7, expectations on wage rates (P^e_L), labour supply (ℓ^e_s), number of civil servants (ℓ^e_g), and nominal demand (Y^e) are extrapolations of actual values, using the weighted average rate of growth over the past ϑ years as the factor of extrapolation.

For s = 1,2, the expected output price level equals

$$P^e_{y_{t+s}} = \text{maximum of } \frac{Y^e_{t+s}}{y^e_{t+s}} \quad \text{and} \quad \alpha P^e_{L_{t+s}} \tag{4.5}$$

If the first term on the right hand side determines prices, the conditions of the supply-model are expected to apply in t + 1 or t + 2 ($model^e = 0$). If the second term equals prices, the demand model is expected to obtain in those periods ($model^e = 1$).
In that same sequence, expected real output equals

$$y^e_{t+s} = \text{minimum of } cap^e_{t+s} \quad \text{and} \quad \frac{Y^e_{t+s}}{\alpha P^e_{L_{t+s}}} \tag{4.6}$$

In (4.6) the expected maximum output equals

$$cap^e_{t+s} = \text{minimum of } \frac{1}{\alpha}\,(\ell^e_{mmax,t+s}) \quad \text{and} \quad \frac{1}{\kappa}\,k^e_{t+s} \tag{4.7}$$

where the expected capital stock

$$\text{for s = 1} \quad \text{equals} \quad k^e_{t+1} = k_t - i_{t-\vartheta} + i$$

$$\text{for s = 2} \quad \text{equals} \quad k^e_{t+2} = k_t - i_{t-\vartheta} + i - i_{t-\vartheta+1} + i^e_{t+1} \tag{4.8}$$

In (4.8) the expected investment in t + 1 is needed. Obviously, the entrepreneur deciding on his investments under conditions of perfect competition cannot take actual i_D here: he will have an assumption with regard to macro-economic investment activity. We assume here (as well as in Chapter 6) that he will estimate them to equal current investment (i) extrapolated with a factor equal to the weighted average rate of growth in real final demand (g+c+x) over the past ϑ years.

If the game leader decides to choose this version of the game, the model equals the one used in the previous chapter where the investment equation is replaced by the set (4.1)-(4.8).

Section 3 Comparison of the investment sectors

At first sight there is a strong resemblance between the investment sector presented above, (4.1)-(4.8), and the traditional one used in Chapter 3, if the discount factor is left out in the new set: substitution of $(Y-Y_L-\delta kP_y-(O_p-B))_{-1}$ for $Y_{R_{-1}}$ in the equation concerned (3.6) -under the assumption that the deflator P_y is left out- and division by k_{-1} results in

$$\frac{i}{k_{-1}} = q(1-\bar{T}_{R_{-1}})\left[\frac{1}{\kappa}(P_{y_{-1}}-\alpha P_{L_{-1}}) - \delta P_{y_{-1}} - \frac{O_{P_{-1}} - B_{-1}}{k_{-1}}\right] + \delta \frac{k}{k_{-1}} \quad (3.6)'$$

where (O_p-B) should be read as interest paid minus interest earned and q for the moment indicates the reaction coefficient (assumed equal to 1 in equation 3.6). The resemblance is even stronger if a lag between the decision to invest and the actual investment (see above) is introduced into (3.6)'.

Major differences between the respective investment functions are, however:

1. The right hand side of (3.6)' refers to the profitability of machines actually in use, whereas in the current chapter profitability of new machines determines investments. The latter is more correct.
2. In (3.6)' the current profitability (of all machines) is considered to be of importance to the investor, while in this chapter the expected (marginal) profitability of machines is taken into consideration.
3. In (3.6) the discount factor is left out. This discount factor is one of the ways through which monetary policy will now influence investment behaviour (see below).
4. Part (4.8) of the investment equation is lacking in the traditional assumption with regard to investment behaviour. Although in line with the assumption of perfect competition, the latter allows capital expansion to take place even if it is obvious that these extra machines will be out of operation because of an expected shortage of labour.

Moreover, as shown in the final section of Chapter 3, the traditionally assumed investment equation can produce perverse, marginal or zero influences of monetary impulses if combined with a monetary sector as the

one described in Chapter 2. This is no longer true if the present investment equation is used (see below). Together with the differences listed above, this provides a serious argument for the game leader to prefer (4.1) - (4.8) to (3.6) and (3.6)' respectively, especially if (s)he wants to include a monetary sector in the game. A monetary contraction (leading to a rise in interest rates) will now lead to a fall in NP^e and thus investments, because:

1. interest charges on new investments will always go up;
2. the discount factor goes up implying a lower net present value of future profits (NP^e).

Consequently, a monetary policy will now, generally speaking, have its intended effects on investment.

Section 4. Description of some impulses

In Chapter 3 the effects of impulses if $\frac{m}{c}$ reacts immediately to relative price changes were contrasted to the ones if $\frac{m}{c}$ reacts with a delay. The latter case was especially useful for demonstrating the J-curve. Since students normally play with different levels of complexity, starting with the one depicted in Chapter 3, a further illustration of this curve would be less useful.

Consequently, we will confine ourselves here to a description of the effects of impulses under the more simple assumption of an immediate reaction in the $\frac{m}{c}$ ratio, concentrating, due to the difference between this chapter and the preceding one, on investment behaviour and on possible monetary aspects.

In Section 4A impulses are presented without an explicit monetary sector. In Section 4B, a monetary sector is included, but there is no international capital mobility. Finally, in Section 4C some impulses are discussed assuming both a monetary sector and international mobility of capital. That section is subdivided into 4C.1, assuming fixed (but adjustable) rates of exchange, and 4C.2, discussing flexible rates of exchange.

Section 4A. Impulses without monetary sector

The results if none of the groups manipulates its instruments are presented in Table 4a.1. This leads to the same stationary economy as the one described in Table 3a.1. Since output prices and production costs are expected to stay equal, expected profits will remain zero. Hence net investment decisions (and consequently net investments) are zero, keeping the capital stock at its initial level. Welfare falls at a rate of 0.25 a period for reasons described in Chapter 3.
Analogous to that same chapter, this section will be subdivided into
a. a government expenditure impulse
b. a wage impulse
c. supply-side policy
d. the demand branch.

Moreover, an extra subsection, e, is devoted to various types of import tariff policy (including customs unions). As we prefer the investment sector of the present chapter to the one of Chapter 3, we will use the former when analyzing import tariff policy.

Section a. A government expenditure impulse ($\bar{g}$)

Assumptions: no monetary sector, world-wide impulse
The main results of a world-wide increase in government expenditures of 10% are shown in Table 4a.2. Coefficient c536 of equation (4.2), q, was set at a level (of 30) resulting in virtually identical first two periods (t=2 and t=3) in Tables 3a.2 and 4a.2.
The explanation of investment behaviour, however, is different now. Because of the impulse, an immediate nominal increase in production is obtained, causing expected nominal production to increase as well. Given an expected fixed capital stock, and thus an unchanged expected real output, this enhances expected output prices and thereby net investment decisions.
This causes investments to go up in period $t = 3$ and with real output still fixed, this leads to a further price increase, higher nominal production (both actual and expected) and higher profits. In Table 3a.2 the

latter causes net investments to rise further. In the current table, however, net investment decisions fall. This is explained as follows.
On the one hand, the increase in nominal expected production forces expected output prices up. On the other hand, the expected capital stock in $t = 3$ is no longer constant, due to the positive net investment decisions of the previous period. This raises expected real output, causing P_y^e to fall. This causes a fall in net investments: in this model only containing (explicitly) a real sector, the price of capital is a constant fraction of output prices, and with P_L (and thus P_L^e) constant, the only determinant of net investments is the expected output price level.[8]

Net investments remain positive, however, causing a gradual increase in the stock of capital, both actual and expected. Together with a continuous drop in expected nominal production (caused by a gradual decline in output prices), the latter ensures a continuous fall in expected output prices (and thus in net investments) until period 9.
In that period a cyclical revival of net investment is obtained, explained as follows. Although nominal production in that period is lower than in the previous one, the expected rate of growth is higher (albeit still negative) causing an on balance increase in nominal expected demand and thus in expected output prices and in net investments. The reason the expected rate of growth is higher lies in the fact that while formulating expectations only the last 8 years (in this case 5) of the development in Y are taken into account. This implies that the early years of rapid decline in nominal production lose their impact as time goes by.

Although the trigger for net investments differs from the one in the previous chapter, causing different developments in the medium term, the long run situation is identical, with capital stock, output and employment expanded and prices back at their initial levels.

Assumptions: no monetary sector, unilateral impulse, fixed exchange rates
With an unilateral impulse in government expenditures (see Table 4a.3), the analysis runs along very much the same lines. Just like in Chapter 3, the difference lies in the "leaking away process" starting when employment in country one starts to grow, i.e., period 4 (see Table 3a.4). Since part of the extra earnings are directed to imports, nominal production (both

actual and expected) falls if compared to Table 4a.2, causing expected output prices and investments to be lower. By the same token, in the outside countries the process of net investment decisions starts in that period.
In the long run the economies of Tables 4a.3 and 3a.4 are identical.

Section b. A wage impulse ($\bar{P}_L$)

Assumptions: no monetary sector, world-wide impulse
We start by analyzing the major consequences of a multilateral wage increase to keep competitive positions unchanged. Table 4a.4 shows that expected output prices and expected production costs rise equally. Consequently, "i_D" will not deviate from the zero-level it started with. Note, however, that expected wage costs (as expected output prices) initially rise by more than the 10% impulse; they rise by 17.5%. Their expected rise relative to actual wages gradually declines until after 8 years (i.e., in period 7) they equal actual wages. This is due to the way expectations with regard to wages, for example, are formed.

As with a worldwide wage increase in the previous chapter (see Table 3a.6), Table 4a.4 produces as the sole impact a once and for all increase in the price level.

Assumptions: no monetary sector, unilateral impulse, fixed exchange rates

The next table (Table 4a.5) shows the most important effects of a wage impulse of 10% in country one solely. For the same reason as given with this impulse in the previous chapter (Table 3a.8), output prices in country one will rise by less than 10% now.
As a consequence, nominal production rises less. Hence expected output prices will rise by less than the 17.5% expected wage increase invoking decisions to divest. This causes investments to fall in period 3. As a consequence, output prices fall leading to a lower nominal production (both actual and expected). As such this forces expected output prices down. But due to last period's negative investment decisions, expected output falls, forcing expected output prices up again. On balance output prices fall but not as fast as expected wages. This explains the smaller net disinvestment decisions in period 3.

In the subsequent periods, this trend is reinforced by lower real output (due to the disinvestments) forcing output prices up. This cannot help expected nominal output to fall on balance (due to the formation of expectations). But together with a decline in expected production capacity (y_1^e), expected output prices do not fall as sharply as expected wage costs. As a consequence, net investment decisions gradually fall to zero.

On balance, the same developments as in Table 3a.8 took place, resulting in lower production and employment and 10% higher output prices in country 1, whereas in country two, due to the switch to their products, employment and production have increased at output prices that have returned to their initial value.[9]

Section c. Supply-side policy

Assumptions: no monetary sector, unilateral impulse, flexible exchange rates

If the government decides to reduce profit tax rates in a situation where net expected profitability equals zero (as in the starting position), that policy would have no impact. Therefore, as in the previous chapter, we combine this policy with an expansion of material government expenditures (also in country one) assuming flexible exchange rates. See Table 4a.6. This table should be compared to Table 3a.10 to discover differences caused by the alternative investment behaviour. It should be compared to Table 4a.6' (increase in government expenditures in country 1 with flexible exchange rates) to discover the effect of the tax rate policy.

As in Chapter 3, the tax rate policy has no influence on the long run. Before that new equilibrium is reached, investments oscillate more, again as in Chapter 3. The reason for the wider oscillation (compared to Table 4a.6') is that, since in period two net investment decisions are higher, in period three total demand is higher, leading to a higher output price, and a consequently higher nominal output, both actual and expected. The latter causes expected output prices to be higher, although in that period real expected output is higher, too (due to a larger expected capital stock). Hence, in that period net investments are still higher than in Table 4a.6'. But owing to the invoked investment activity, expected output

accelerates, pressing expected output prices (and as a consequence the investment activity itself) down again.

So, once again, in a model explicitly containing only a real sector, the alternative investment sector, in a qualitative sense, does not change the outcomes of the impulse.

Section d. The demand branch

Assumptions: no monetary sector, world-wide impulse

To compare investment behaviour in the "demand-branch" in the respective chapters, Table 4a.7, which focusses on a world-wide labour tax increase of 20%, is included (analogous to Table 3a.11).

Owing to the impulse, the consequent drop in consumption forces the variable 'model' to switch to 1, indicating that the horizontal branch of the supply curve applies.

Due to the fall in nominal production, expected nominal output falls as well: actual and expected output prices equal (rigid) actual and expected labour costs (0.8). The expected value of 'model' equals one. As long as this holds, the difference between expected output prices and costs is at a constant level of -0.16.[10] Nevertheless, net disinvestments gradually decline as time goes by (see Table 4a.7). In Table 3a.11 a similar phenomenon could be noticed,[11] but the explication is now different. The phenomenon halting the disinvestment process in the present table is not (as in Table 3a.11) explained by a declining actual underutilization of capital (causing lower losses), but by a lower expected rate of underutilization.

In t = 2, the expected stock of capital drops very mildly (as a consequence of lower expected final production) to 99.4, indicating that according to expectations, about 27% of capital will be out of operation (k^e/y^e = 99.4/78.1 = 1.27).

The consequent net disinvestment in period three pushes (nominal and real) expected output down further, indicating a higher than 27% expected underutilization. But the same disinvestments force the expected capital stock down to a larger extent (to 93.47, not shown in the table). This results in a lower expected underutilization rate (23%). As a consequence, net disinvestment decisions in t = 3 are smaller than those in period 2.

From period 4 onwards, expected nominal output increases, although actual nominal production still falls. This is explained by the structure of expectations: as time goes by, the impressive drop in nominal consumer demand in period two gets a lower weight in determining expected nominal demand. So, although the expected rate of growth in Y is still negative in period 4, it is less negative than it was in the previous period. On balance, expected nominal (and real) production goes up. This causes the gap between the expected capital stock and the expected output to shrink further. In period 6 the expected capital stock is again the bottleneck for production (as a consequence, P_y^e exceeds P_L^e in that period), whereas in that period the (actual) stock of capital still exceeds (actual) output (hence, $P_y = P_L$).
Compared to Table 3a.11, the variable 'model' returns to its original value one period later now, caused by smaller disinvestments in the present case. But the pattern of adaptation is, roughly speaking, again the same in both chapters. The long run outcomes are also identical.

Section e. Protection

In this section we will look at various types of import tariff policy (a world-wide increase in tariff rates, a unilateral increase in tariff rates and the creation of customs unions).

First, in Section e.1 we assume, as in the basic version of the game, that import tariff revenues are not redistributed to households. Then, in Section e.2 this assumption is revised in the sense that tariff revenues are fully repaid to households.

An important difference between the two alternative assumptions can be traced by recalling the initial hypothesis with regard to consumer behaviour.
The household budget constraint

$$C + (M+BT) = Y_L + TRF - B_L$$

(where M + BT represented the tariff inclusive value of imports) was re-written as

$$C = Y_L + TRF - B_L - M - BT$$

The division between consumption and imports was such that

$$\frac{(M+BT)}{C} = \varepsilon$$

where $\varepsilon = \frac{16}{60}$.

In other words, the budget constraint could also be written as

$$(1+\varepsilon)C = (Y_L+TRF-B_L)$$

As a consequence,

$$C = \frac{1}{1+\varepsilon} (Y_L+TRF-B_L)$$

So, in Section e.1 the nominal value of consumption of home produced goods only changes if nominal net income changes.

The alternative, with tariff revenues redistributed, as assumed in Section e.2 below, implies the budget constraint:

$$C + (M+BT) = (Y_L+TRF-B_L) + BT$$

or

$$C = \frac{1}{1+\varepsilon} (Y_L+TRF-B_L+BT)$$

As a consequence, in Section e.2 below, nominal consumption of home produced goods cet.par. rises if import tariffs are levied by $\frac{1}{1+\varepsilon}$ times the revenue. The reverse also holds: if the tariff revenue falls, home consumption of home produced goods declines by $\frac{1}{1+\varepsilon}$ times that fall.

Obviously, a second difference between the two assumptions regards the government budget surplus. With tariff revenues redistributed to consumers, they disappear from the equation concerned.

Section e.1

Assumptions: import tariff revenue is not redistributed, no monetary sector, fixed exchange rates

The main consequences of a world-wide switch from free trade to import tariffs of 20% in period t = 2 are shown in Table 4a.9. The welfare effects are clearly negative, not only in the short run, but also in the long run.

The main cause is that, with such an impulse, real net consumer income (w_B) is lowered, while consumer expenditures are, in all countries to the same extent, switched from imports to home produced goods. So, every country will experience lower private demand (in nominal terms) for its products (C+X), causing a drop in expected demand, output prices and consequently in net investments. Therefore, over time all determinants of welfare -except for the balance of payments, of course- force welfare down when compared to the situation of no intervention.

The most important influences of a unilateral action in this respect are shown in Table 4a.10: the implementation of a 20% import duty in country one without retaliation by the other countries.

As shown above as well as in Appendix 2.2, in the short run,[12] the relative price change for consumers in country one will on balance leave the volume of home consumption[13] (and exports) intact: the rise of P_m does not influence home consumption. As total demand for those goods is unchanged, product prices in country one will remain one. Expected nominal demand is not affected, either. Therefore, expected output prices remain at their previous level, and so do net investment decisions.

However, the artificially increased import price causes imports out of the rest of the world to decline and, as a consequence, their product prices will fall. Hence, real net labour income in those countries goes up, causing consumption of home produced goods and imports (out of each other[14]) to go up, as well. The fall in product prices will depress

both expected demand and expected output prices. Decisions to divest are taken. Since imports into country one are forced back in period two, given the way expectations are formed, expected nominal demand after a few periods will start to grow again. This together with a declined expected production capacity leads to higher expected output prices mitigating disinvestments.
Welfare developments in the respective countries are rather interesting here. In the short run, the protecting country (country 1) harms its own welfare. This can be attributed to a severe drop in private final absorption (the drop in imports), an unstable government budget (the import duty revenue) and fluctuating prices.
In the longer run, however, welfare in the home country is still harmed by this kind of protection, but its counterpart in the outside world falls extremely sharply, mainly as a result of increased unemployment, a deficit on the current account and an unbalanced government budget.

These respective welfare developments will invite the outside countries to retaliate. Once protection starts, a situation of global tariffs as described above might be the result, with all countries worse off than without protection (in any country), but better off than if they were excluded. (Compare Table 4a.9).

Suppose such a world with all countries levying (for convenience) identical import tariffs is indeed the outcome. Will it then be favourable to create a customs union with two or three countries ? Within the framework of the model concerned here, the answer can be given with the help of Tables 4a.12 and 4a.13.

For technical reasons the impacts of customs union formation (in period $t = 2$) are more easily generated in a world where global tariffs are already uniform in period zero. To give a fair impression of customs union effects, the resulting figures -as given in Tables 4a.12 and 4a.13- should therefore be compared to the figures of Table 4a.11: the situation with all countries indiscriminately levying import tariffs of 20% from period zero onwards.

The main consequences of the formation of a customs union in period two by countries 1 and 2 are listed in Table 4a.12. In that period

they abolish import duties on their bilateral trade flows, leaving the other import tariffs unaffected (i.e., t_{ij} = 20% for all i, j, except $t_{12} = t_{21}$ = 0%).[15]

Since imports out of countries 3 and 4 are as expensive as they were without the customs union, comparison of Tables 4a.11 and 4a.12 shows that, in volume, those trade flows are unaffected. International trade flows inside the customs union as depicted by m_{12} (= m_{21}) will, however, by the same token, increase: after tariff prices of those imports go down. In itself this will force pre-tariff prices of those products up again (P_y goes up). That is why consumption of home produced goods in the partner countries falls in real terms and due to increased actual and expected nominal demand, expected output prices rise, causing fewer divestments. And for the same reason (P_y in the customs union going up) imports out of the customs union by countries 3 and 4 (as indicated by m_{41}) will go down a bit.

The most important shift is, however, immediately obvious from the respective tables: trade between the partner countries increases, pushing pre-tariff prices and thus investment activities in those countries up. On the short run welfare in the block countries increases slightly, mainly due to a more balanced government budget. On the long run, however, welfare developments are more pronounced: the increased investment activities in the block countries, or rather the lower disinvestments, will allow more employment and more private spending opportunities than without a customs union.

Welfare in the outside world is only harmed to a minimal extent.[16] The traditional, classical fear of 'trade diversion' that might harm world welfare is not justified in this model.[17] World welfare, not only in the short run but especially in the long run, is improved by customs union creation.[18] The gain in welfare for the larger part goes to the block countries without any serious harm to the outside world. On the long run, the latter even benefits as a consequence of increased exports to the block countries causing its trade balance to be in surplus.

If the customs union contains three, as opposed to two, partner countries, the above conclusions are all the more true. As a consequence,

welfare in the partner countries is raised even further than in the preceding case. This can be verified by studying the figures in Table 4a.13. This table refers to the creation of a customs union by countries 1, 2, and 3 in period t = 2, leaving 4 out.

The final step would be to include even country four in the block, which would in fact imply a return to free trade in period two. Obviously, this step favours welfare the most (see Table 4a.14), which is perfectly in line with the Cooper-Massel proposition,[19] in the sense that a customs union is in general inferior to a step towards full liberalization of trade.

Table 4a.14 in fact refers to a short period of global protection (periods 0 and 1) followed by a return to free trade. As a consequence, the economies return to their initial positions. Although preferable to a customs union, comparison between Tables 4a.1 and 4a.14 teaches us that it is better to leave out all protection.

It should be stressed that we do not claim to have illustrated the Cooper-Massel proposition here. Trade creation and trade diversion are classical concepts to which our model cannot be applied. The only thing stated is that the developments in welfare as defined in the game using its basic model do not contradict the ones described by classical literature.

The picture described above changes drastically if the government is assumed to redistribute its tariff revenues for 100% to households. This is illustrated in the next subsection, e.2.

Section e.2

Assumptions: import tariff revenue is redistributed, no monetary sector, fixed exchange rates

As stated in the introduction to Section e, if the government reimburses its tariff revenues to households, as assumed here, nominal home consumption increases, with far reaching consequences for the impacts of trade policy.

In Table 4a.9' describing the effects of global protection from period two onwards and to be compared to Table 4a.9, nominal consumer spending goes up from 60 to 62.1818.[20] This compensates for the deflationary impulse

found in Table 4a.9, if added to extra (nominal) demand for imports out of country one by consumers in the rest of the world.
As a consequence, with restitution, protection not only discourages imports, as in the previous subsection (e.1), but also encourages (nominal) home consumption.
Since the increase in nominal consumption equals the decrease in nominal exports, output prices are left unaffected. Therefore, both actual and expected nominal demand are constant, leaving expected output prices as well as net investments at their previous levels. The only impact of uniform and global protection is a one time increase in the overall price level, causing a one time downward shift in welfare (obtained in the impulse period). Without restitution, the resulting deflationary impulse led to net disinvestments and a downward shift in production and employment and, in the long run, to a disappearance of the initial government budget surplus (mainly due to increased unemployment benefits).

If only country one raises its import tariffs, the results are shown in Table 4a.10', to be compared to Table 4a.10 without restitution. The fact that the import tax revenue is now (partly) directed to home consumption constitutes an impetus to local consumption and (in the longer run) to production. In contrast to Table 4a.9', defeated exports (due to outside tariffs) no longer compensate for this impulse. Consequently, the present table shows an increased demand for home products, initially virtually only in nominal terms, but later, when supply has adjusted, in real terms. The increase in employment ensures that welfare will rise, even if compared to the no-intervention case (Table 4a.1), after an initial decline, because of price movements and a fall in private final absorption.
Comparing Tables 4a.10' and 4a.10 indicates that only with restitution of tariff revenues can import tariffs be regarded as a true expenditure switching device in the long run. The increase in home production in the long run equals the reduction in outside production in Table 4a.10', whereas in Table 4a.10, production falls all over the world. In both cases the home country runs a surplus on its current account as soon as the tariff is installed as well as in all periods to follow.
Moreover, in both cases welfare in the outside world is harmed by the imposition of a tariff. But, whereas in Table 4a.10 welfare in the home

country was harmed as well (as in neo-classical trade theory[21]), with restitution of the revenue welfare (in Table 4a.10') was increased in the long run. The latter is not only explained by a government surplus (explained by higher labour tax revenues and fewer unemployment benefits) with an equal counterpart at the trade balance, but also by a lower rate of unemployment.

We can conclude that if the game is changed to allow for redistribution of import tariff revenues, unilateral protection pays after a few periods. The outside world, however, is still harmed, inviting them to retaliate. So, again, the situation of global protection might be the ultimate outcome.

Is a customs union then still attractive without harming the outside world? No. To illustrate this, Tables 4a.12' (customs union between countries 1 and 2) and 4a.13' (idem, between countries 1, 2 and 3) are included, analogous to Tables 4a.12 and 4a.13, respectively, where the customs union effects are detected by a comparison to Table 4a.11'. In essence, the latter table is a copy of the stationary situation of Table 4a.9'.

Obviously, in Table 4a.12' intra-block trade increases: country one's products are now cheaper in country two, and vice versa, which is the same phenomenon as without redistribution (Table 4a.12). But an extra (negative) impetus is given here in the form of a negative compensation of household income caused by lower tariff revenues in countries one and two. As a consequence, prices increase less than they did in the situation of no (negative) restitution to consumers (compare Tables 4a.12' and 4a.11' on the one hand, and Tables 4a.12 and 4a.11, on the other). The impetus on demand and investment is therefore less. Consequently, production grows in the block countries, but less than in the 'non-restitution case'.[22]

If three or even four countries join the block, exports by the partners rise faster than if only two countries were members. But the negative restitution effect also grows and outweighs the positive effects of increased block trade. This is most easily seen in Table 4a.14' where in period two the initial starting position is restored again (return to free trade). That is why the output price increase in Table 4a.13' is less than in Table 4a.12', with the well known impact on actual and expected nominal income, on expected output prices and, consequently, on net investments.

Still, a customs union of two or three countries benefits welfare in the long run, due to a (limited) balance of payments surplus, a government surplus and decrease in the rate of unemployment and unstable prices during the adjustment process. In the outside world welfare drops as a result of the shift feature of import tariffs. Total world welfare declines. In this sense, the Cooper-Massel proposition also holds in the "restitution-case": full liberalization of trade (Table 4a.14') results in a higher level of world welfare than a customs union.

Above we analysed the consequences of customs union creation in a world of protection. An alternative would be to start in the original Table 4a.1 situation of world-wide free trade.
The consequences of a two-country block in that situation are depicted in Tables 4a.15 (customs union between countries 1 and 2, no redistribution) and 4a.15' (idem, with redistribution). In the former case, initially nothing much happens within the block. Only imports out of countries three and four decline.[23] This creates a fall in their output prices, followed by divestments. Once employment in the outside countries drops, exports by the block countries start falling, with the known consequences for investments and production. Hence, a customs union is first of all bad for the outside world, dragging the block production along.

But with restitution (see Table 4a.15'), the "purely switching feature" ensures that production in the block countries rises, whereas outside production falls. The long run welfare effects are evident.

Summarizing, the question whether a customs union in the long run improves or harms welfare and production in the block countries and in the outside world can be answered by the matrix in Diagram 4.1, where y denotes the real product by firms, W represents welfare and the superscripts B, * and w refer to block, the outside countries and world, respectively. The symbols >> and << mean "much larger" and "much smaller", respectively. Finally, ≈ 0 means "about zero".

starting position → ↓ restitution/ no restitution	global protection	free trade
no restitution of import tariff revenue	$\Delta W^B > 0$, $\Delta y^B > 0$ $\Delta W^* \approx 0$, $\Delta y^* \approx 0$ $\Delta W^w > 0$, $\Delta y^w > 0$ (Tables 4a.12-4a.11)	$\Delta W^B < 0$, $\Delta y^B < 0$ $\Delta W^* << 0$, $\Delta y^* < 0$ $\Delta W^w << 0$, $\Delta y^w < 0$ (Tables 4a.15-4a.1)
with restitution of import tariff revenue	$\Delta W^B > 0$, $\Delta y^B > 0$ $\Delta W^* < 0$, $\Delta y^* < 0$ $\Delta W^w < 0$, $\Delta y^w = 0$ (Tables 4a.12'-4a.11')	$\Delta W^B > 0$, $\Delta y^B > 0$ $\Delta W^* << 0$, $\Delta y^* < 0$ $\Delta W^w << 0$, $\Delta y^w = 0$ (Tables 4a.15'-4a.1)

Diagram 4.1: effects of a customs union

In none of the situations does the outside world benefit by the customs union in the long run. The block countries benefit if the starting position is global protection. If it is free trade, they only benefit if tariff revenues are redistributed. Only if tariff revenues are not redistributed, are the ultimate impacts of customs union creation in line with the traditional ones: a customs union is preferable to global protection but inferior to free trade. If those revenues are, however, redistributed (i.e., if import tariffs are used in a truly expenditure switching way), those conclusions are severely violated: for the block countries a customs union is still preferable to global protection, but welfare in the outside world suffers more. As a result world welfare drops if in a world of protection a customs union is created. Moreover, countries can gain both in welfare and in production in a free trade world, if they decide to create a customs union. Also in this case world welfare is harmed, however.

As stated in Chapter 3, one of the main reasons to prefer the investment equation used in the current chapter is the expected logical impact of monetary policy. That is why we now turn to an analysis of impulses in a model combining the real sector given above and the monetary sector described in Chapter 2.

Section 4B. With monetary sector; no international mobility of capital

Before dealing with the consequences of monetary policy, we will first look at the 'economy of no intervention'. This situation is presented as Table 4b.1. The starting values -see below- are chosen such that the real sector is constant, while the monetary sector is only constant in the interest rate, the transmission factor from the monetary to the real block. This implies that the outcomes of impulses to be shown below should, for monetary variables -except for interest rates-, not be compared to the starting values (period one), but to the figures in Table 4b.1. Note that since inclusion of the monetary sector implies disappearance of F in the welfare function, the bonus points for F = 0 without intervention are no longer earned. Consequently, the 'automatic' drop in welfare is larger now: 0.5 point a period.

The trend in the monetary sphere is necessary in order to allow for wealth owners. If this category exists, wealth exists, probably partly invested in bonds. These bonds give rise to interest proceeds (again at least partly invested in bonds); so, bond demand and wealth will continuously go up. To get a stationary rate of interest if no interventions are made, the former is balanced by an increase in the supply of bonds by the government. Given the assumed initial behaviour of portfolio investors (see below), in the starting position the government is assumed to finance half of its deficit through issuing bonds, i.e., initially $\alpha_1 = 0.5$. Over time such a behaviour implies increasing government expenditures (interest charges go up), which increases F again. The trend concerned here equals 2% addition per period, equal to one half of the initial net interest rate. [24]

The remaining starting values are chosen as follows. An interest rate of 10% increases the rental price of capital by 10% of the output price level if compared to the assumed 0% rate of interest when the monetary sector

was not included. To compensate, ϑ (the life span of a machine) is doubled to 10 as soon as such an (explicit) monetary sector applies.[25] This way the rental price is kept constant relative to the model without a monetary sector.

Out of a portfolio (wealth, V) in t = 0 equal to 300, given interest rates of 10%, the first half is invested in bonds (each valued at 1/0.1), the other half is held in cash. Consequently, the number of bonds in t = 0 is 15, equal to interest proceeds (00) in period t = 1. Interest proceeds are paid by the government (0_g=5) and by firms. Firms not only pay interest to wealth owners, but also to other firms. In period t = 1 the latter part (not included in 00[26]) equals 1, the former equals 10. As stated in Chapter 2, depreciation charges in t = 0 are invested in bonds and lead to interest proceeds (labelled B) of 1 (= 10% of δkP_y) in t = 1.[27] In the starting position, the extra demand for bonds by firms (equal to depreciation allowances) equals extra supply by firms (the externally financed investments).

A summary of this starting position is given in Appendix 4.1.

In this section, we will subsequently discuss the following impulses:

a. An increase in material government expenditures
b. An increase in the wage rate
c. Supply-side policy
d. Monetary policy

a. An increase in material government expenditures

Assumptions: monetary sector, world-wide impulse

Table 4b.2 relates to a global government expenditure increase of 10%.[28] In the impulse period, investment decisions go up as a consequence of higher output prices increasing Y^e and thus expected profitability of investments. The increase is attenuated, however, by the rise in interest rates, caused by an increase in the number of bonds supplied by the government, financing its increased deficit for 50% via 'neutral' means. (That is, with $\bar{\alpha}_1$ assumed to be unchanged at 50%, the increased deficit will lead to more bonds).

In the next period, the government deficit falls, as a result of higher profit- and interest-tax receipts. Nevertheless, the interest rate rises further, which is not only caused by the extra supply of bonds by firms (to finance their extra investments): the government deficit is still high when compared to Table 4b.1 and to total portfolios. It should have dropped further to facilitate a decline in the rate of interest. Again, the interest rate constitutes a break in business expansion, albeit a mild one. The other factor explaining the fall in net investment decisions is the one familiar from Table 4a.2: a decline in the expected output price level caused by an increase in expected output (due to last period's net investments).

Capacity expansion in the subsequent period leads to falling prices, lower net investments (together with a lower deficit, caused by lower unemployment, decreasing the interest rate through fewer extra supplied bonds), etc.

The nature of the adjustment process is hardly influenced by the introduction of a monetary sector, if we compare this sequence with the one in Table 4a.2.[29]

Assumptions: monetary sector, no ICM[30], unilateral impulse, fixed exchange rates

The same holds for the implications of a unilateral increase in G, see Table 4b.3. One remarkable aspect of this table, however, is the development of interest rates in the outside world. Although absence of international capital mobility is assumed, these interest rates are nevertheless affected, albeit to a very minor extent.[31] Increasing investments abroad are not the main reason for changing interest rates in those countries, since they are hardly affected. The main factor at stake here, is on the one hand a lower deficit on the government account (caused by more exports -and thus fewer unemployment benefits- and higher profit and labour tax receipts). On the other hand, profits rise in period 4 in the outside world (due to more exports), in period 5 partly invested in bonds, which drives the interest rate down, too. Obviously, the influence on foreign rates of interest will be larger if one assumes international mobility of capital. (see Section 4C below). Again, the introduction of a

monetary sector does not change the nature of the adjustment process.

b. An increase in the wage rate

Assumptions: monetary sector, world-wide impulse

It may be remembered from Section 4A above (see Table 4a.4) that if wages rose all over the world, nothing happened apart from a one time price increase. This resulted from the fact that all (expected) costs rose to the same extent as the output price level. An identical impact was found in Chapter 3 (see Table 3a.6). Now, in a model including a monetary block, this is no longer true. Capital costs are only partly linked to the output price level expected for t + 2. The remainder is linked to the interest rate and the output price level expected for t + 1. They are not changing proportionally. This is illustrated in Table 4b.4, presenting the impacts of a global 10% wage rise. To equilibrate demand and (fixed) supply, output prices rise by 10% in the impulse period. This is due to the fact that all households earn 10% more, nominally: civil servants and unemployed also get the 10% wage increase. But, by the same token, the government deficit increases, forcing the interest rate up.

At a fixed expected (real) output for two years ahead, the 10% increase in P_y causes a 14% increase in nominal demand and hence output prices expected for two periods ahead rise similarly. The price level expected for one year ahead is lower. Given the (marginal) increase in the interest rate, expected capital costs rise less than expected wage rates and output prices - all for t + 2: when machines are bought (i.e., in t + 1) prices are expected to be lower than when they are in use (i.e., in t + 2).[32] As a consequence, expected financing charges are relatively low. This leads to an expansion of the capital stock (including the one expected), forcing output prices in the longer run down again.

Note that in the long run, the situation of the impulse period reappears, except of course for the monetary variables (including F) and the variables concerning expectations. This also holds for gross profits: with production at its previous level and sold at prices 10% higher, just as labour income and depreciation charges, a constant interest rate leaves room for positive profits.

In the previous chapter with investments depending on actual profits, this could not have been a long run equilibrium position.
Apart from that, although the adjustment process was influenced, the new equilibrium position reflects the one familiar from Chapter 3: apart from a higher wage-and-price level, no real impact of a world-wide wage policy.

Assumptions: monetary sector, no ICM, unilateral impulse, fixed (cq. flexible) exchange rates

If only country one increases its wage rate, we have to make a distinction between fixed and flexible exchange rates. In the former case (see Table 4b.5), because of its higher output price level, exports by country one fall, attenuating the rise in output prices, if compared to the previous table as well as to the flexible exchange rate case. In the latter, the drop in exports is prevented by a depreciation equal to the impulse (see Table 4b.5'). Adjustments in the exchange rates ensure that here the developments in country one equal those with a global wage increase, whereas the outside world is perfectly insulated. This conclusion could also be drawn in Section 4A above.

With exchange rates fixed, however, in the impulse period, as stated, the output price rise in the home country is mitigated. As a consequence, the government deficit is lower and the consequent rise in interest rates is lower (compared to the other two "wage-impulse-tables"). As such, this would stimulate investments: the expected price of capital is lower. But, owing to falling exports and a consequently lower output price increase, expected nominal demand is lower, causing expected output prices to fall relative to the other two tables regarding a wage increase. If capital costs are subtracted, the outcome is lower than the expected labour costs. The latter equals the one in the other two tables concerned. As a consequence, the wage rise no longer leads to an expansion of the capital stock, but to a decline thereof.
Whereas the outside world experiences the positive effects of a demand impulse (increased exports to country one), the wage increasing country suffers from a contraction. The implications for "welfare" are evident. The nature of the adjustment process as well as the ultimate outcome are comparable to the ones without a monetary sector (see Table 4a.5).

So, with a wage impulse we can conclude that the adjustment process is influenced by the inclusion of a monetary sector if the impulse is either worldwide or is combined with freely floating exchange rates. The new equilibrium position, however, is comparable[33] to the ones found if such a monetary sector is not included.

c. Supply-side policy

Assumptions: monetary sector, no ICM

If supply-side policy (i.e., lowering the tax rate on profits and interest receipts) is applied, the real sector of the economy is still not influenced. The reason is not, as in the previous chapter, that the basis for this tax rate is zero, initially. On the contrary, this basis is now positive, since it is formed by profits and gross interest receipts equal to 15.3 in the impulse period. The reason is explained as follows. At the initial rate of interest of 10%, half of total portfolio holdings are assumed to be invested in bonds. Also, 50% of every increase in wealth, here due to a lower tax rate, is invested in bonds. So a tax cut resulting in a one dollar increase in wealth causes the demand for bonds to go up by half a dollar. The same tax cut, however, forces the government deficit to go up by that same dollar. Since we assumed half of the (extra) deficit to be financed by bonds, this implies a 50 cent increase in the supply of bonds as well. Supply and demand for bonds increase to the same extent. Equilibrium between the two is therefore established at the previous rate of interest. As a consequence, the real sector of the economy is not influenced. Apparently, the neutrality of supply-side policy in this situation can be relieved by changing the initial level of α_1, the degree of monetary financing of the deficit.[34] Another remedy, however, is to introduce international mobility of capital. Therefore, we leave this analysis to Section 4C below.

d. Monetary policy

Assumptions: monetary sector, world-wide impulse

The major results of a global monetary expansion of 10% are listed in Table 4b.6. This impulse is defined as the device whereby the Central Bank

(assumed to be an integral part of the government) buys 10% of the existing stock of bonds owned by the public.[35]

By such a monetary expansion the number of outstanding (government) bonds decreases. This causes interest rates to fall (from 10% to 9.31%, see Table 4b.6): at the initial rate of interest the ratio of money over bonds in the asset portfolios is disturbed. An increased demand for bonds results, causing interest rates to fall. At the lower interest rate (making bond holdings less attractive), a new portfolio equilibrium is established, where the share of bond holdings in the total portfolio drops below the initial 50%. At the same time, due to the interest induced wealth effect, the value of total portfolio holdings increases.
Outside the monetary sphere, nothing happens in the economy in the impulse period except for the fact that, as a consequence of the lower interest rate, the expected rental price of capital falls, causing net investment decisions to rise.

In the subsequent period actual investments rise. As such, this would explain the increase in the rate of interest: all investments are financed by issuing bonds. But the fall in the government deficit (financed for 50% with bonds) exceeds this rise by far. Consequently, the supply side of the bond market would justify a further drop in the rate of interest. However, owing to the previous fall in the interest rate (in period two), net interest proceeds (added to portfolio holdings) have dropped now. Therefore, the increase in total wealth (V) is mitigated, causing (cet. par.) a higher interest rate. Gradually, the interest rate returns to its initial level.

Meanwhile, in period three the gap between expected output prices and expected costs has declined. This is not only due to the higher interest rate explained above, but also to lower expected output prices: net investment decisions of period two now lead to the expectation of a higher future output volume, pressing output prices down.
So, expected profitability of new machines, originally enlarged by expansionary monetary policy, is squeezed by falling output prices on the one hand, and rising costs of capital, on the other. In a period not shown in the table, this leads to net disinvestments, reversing the expansionary trend. This leads us to the provisional conclusion that a global monetary policy in the current model can influence investment and production in the

short and medium term, but is unable to do so in the long run. Obviously, the traditional Mundell-Fleming scheme, where monetary policy is capable of influencing interest rates and production, stipulates the immediate impacts of the impulse (reproduced here as periods 2 to 4), but omits the consequences on interest proceeds, likely to be at least partly reinvested in bonds. Therefore, it cannot claim to produce true long run results.

Assumptions: monetary sector, no ICM, unilateral impulse, fixed exchange rates

This conclusion with regard to the long run inefficacy of monetary policy also holds if the policy is carried out on a "unilateral" scale and exchange rates are fixed. The two tables concerned (Tables 4b.6 and 4b.7) are very much alike. A slight difference, however, lies in the amplitude of the wave invoked by the monetary policy: due to the fact that output prices in country one rise, exports to the rest of the world drop if the impulse is carried out unilaterally. This forces output prices down if compared to its multilateral counterpart. Consequently, the same holds for expected demand. But the main message from Table 4b.6, namely that in the current setting on the long run monetary policy is ineffective, is upheld.

Assumptions: monetary sector, no ICM, unilateral impulse, flexible exchange rates

The same conclusion can also be drawn if exchange rates are flexible. The differences between the table concerned (4b.7') and the one regarding fixed exchange rates (4b.7) lie in the short run and are nearly negligible. They relate to the fact that where with fixed exchange rates a shortage on the trade account evolved, now a depreciation is obtained, attenuating the drop in exports. Furthermore, once again, the outside world is also in the short run insulated through the movements of the exchange rates.

In the long run the expansionary open market policy changes neither any of the real variables, including exchange rates, nor the interest rate. In this sense the exchange rate of country one "overshoots" and its rate of interest "undershoots" its long run value.

The above conclusions with regard to the inefficacy of monetary policy hold (in this version of the model) if the open market operation occurs once. They do not hold, however, if the monetary policy takes the form of a change in the percentage of the government deficit financed by bonds cq. money. In the game this impulse (a change in $\bar{\alpha}_1$) is treated as "permanent unless otherwise indicated". In fact, a 'once and for all' change in $\bar{\alpha}_1$ boils down to a permanent expansionary or contractionary monetary impulse. Formulated this way, each period a new impulse is given, pushing the interest rate down (if the impulse is expansionary). But at the same time, portfolio developments resulting from all previous impulses, push the rate of interest back up again. In the end, an equilibrium between the two is found at a new level of interest rates (and output prices, etc. - see below).

To illustrate that in this case monetary policy is effective, Table 4b.15 is included where, for a change, $\bar{\alpha}_1$ is decreased from 50% to 40% in all countries, indicating that an extra 10% of the deficit is now bond financed. (Still, we do not assume international mobility of capital.) As a consequence, the interest rate continuously rises until a new equilibrium is found at a 12% rate of interest. Due to the sterilization assumption with regard to imbalances on the trade account, a similar but unilateral impulse by country one results in the same effects if exchange rates are fixed (see Table 4b.16) as well as if exchange rates float freely (see Table 4b.16'). Again, in the latter situation. the outside world is insulated.[36]

Finally, in the previous chapter we rejected the combination of the 'simple' investment equation with the monetary sector of Chapter 2 by the use of Table 3b.2, showing results of a government expenditure decrease of 10% in combination with a monetary contraction of 5%. The latter appeared to be expansionary. In the present chapter, however, it was expected to work contractionary with regard to investments. Comparison of Tables 4b.8 and 4b.9 justifies this expectation.[37] The inefficacy of open market policy discussed above, however, ensures that the long run outcomes in both tables are identical.

Section 4C. International mobility of capital

If international mobility of capital is assumed the stock-adjustment feature embodied in the bond demand equation (2.27-2.28) is crucial in analyzing the impacts of intervention. If interest rate differentials are set at a new level, the desired stock of bonds out of each country is set at a new level. This extra demand is immediately satisfied via international capital flows. If net interest rates stay at their new level, cet. par., those capital flows cease to exist. What is left then are international interest payments in the subsequent periods.
In Table 4c.1 the "stationary" situation of no-intervention is given if international mobility of capital is assumed. Due to the assumption of preferred local habitat, holdings of local bonds are twice as high as those of bonds issued in each of the three 'outside' countries. For reasons explained below, this table also includes the values of the profit and interest tax revenue (BR) [38] and the number of bonds issued (O).

If international mobility of capital is included in the model, a problem arises with regard to the accuracy of the calculations in the longer run, which can be illustrated as follows.
Obviously, in a symmetric world with no interventions, no international flows of capital occur: the capital balance, as well as the service account, should be zero. The "zero's" in the respective rows in Table 4c.1 are, however, rounded. In all periods a certain inaccuracy is accepted by the computer. For instance, in periods 200 and 201, with a 7 digit display, the capital account in country one shows a deficit -capital is invested in 'outside' bonds- with a subsequent surplus on the service account.
The latter is after taxation added to the investment portfolio of country one and increases the error in the subsequent period.[39]
In the outside world, the opposite happens. As a consequence, the computer calculates a decrease in country one's interest rate (due to the growth in its wealth), whereas in the other countries the interest rates rise. Therefore, the outflow of capital out of country one is reinforced.
As a consequence, the inevitable inaccuracy of the computer makes the outcomes after period 200 unreliable.[40]

The tables to follow that regard models including international mobility of capital will therefore only relate to the first 200 periods. Obviously, this implies that no conclusions can be drawn on the true long term effects of impulses, unless otherwise indicated.

Given the symmetric world included in the model discussed here, the results with world-wide impulses are identical to the ones presented in Section 4B above, where no international mobility of capital was assumed. For that reason we will concentrate here on "unilateral" interventions. In Section 4C.1 we assume fixed but adjustable rates of exchange and in Section 4C.2 we assume world-wide freely floating exchange rates.

Section 4C.1. Fixed exchange rates

In this section we will subsequently discuss:
a. an increase in material government expenditures;
b. a monetary expansion;
c. an increase in the wage rate;
d. supply-side policy;
e. a devaluation.

a. An increase in material government expenditures

Assumptions: monetary sector, ICM, unilateral impulse, fixed exchange rates

In Table 4c.2 the intervention relates to an increase in material government expenditures in country one. The picture displayed here illustrates that the way the economy behaves now differs essentially from the one excluding the international mobility of capital.

The government deficit in period three is now higher in the home country, and smaller abroad, than it was in Table 4b.3. This is accounted for by the fact that part of the extra bonds needed to finance the deficit in the previous period is bought by foreigners (which drives the outside interest rates up, too). In the current period (period three) the government of country one pays interest charges not only to home citizens (as in Section

4B), but also to those foreigners. In turn, they pay part of these proceeds as tax to their own government. Where in Section 4B 60% of total government interest payments were received back as interest tax, now the government in country one "subsidizes" the other three governments.[41] This higher deficit prevents the interest rate from falling (as it did in Table 4b.3). In the subsequent periods, the home country's government, due to the higher interest rates faces larger interest charges, a consequently higher deficit and a higher interest rate, and so on. The opposite happens in the outside world. A consequence, the flight by all wealth holders, including those abroad, to bonds issued in country one[42] mitigates but cannot prevent the gradual widening of the gap between the "two" interest rates.

The introduction of international capital mobility inserts a source of instability into the model. Although this could probably be prevented by treating the interest tax as a "withholding tax", this has purposefully not been done in the game so far. The reason is straightforward. Although some countries apply a withholding tax regime to interest proceeds, others, among which the Netherlands, do not (yet). Moreover, the phenomenon described above might be traced to the reality of international economics: the international debt crisis. Furthermore, this way, the idea is illustrated to players that an increase in government expenditures, given the method of financing, necessitates future expenditure cuts. Finally, the price of consols (inverse of the rate of interest) should be calculated differently then, see Appendix 2.3. If so, one major advantage of choosing 'consols' as the form of bonds is lost.

Returning to Table 4c.2, it can be observed that in the impulse period, the increase in the 'home' interest rate is smaller than without international mobility of capital: the rise attracts capital from abroad (see KAB1>0), mitigating the increase as such. Abroad, the interest rate goes up as a result of the lower availability of capital.[43]

Whereas in previous tables the expansionary policy at home could be regarded as 'supporting' with regard to production and employment objectives abroad, in the short term it can now be regarded as 'conflicting'. The higher interest rate depresses profit expectations and there-

fore net investment decisions. As a consequence, in period three investments fall. Together with the slightly lower government deficit, caused by higher interest tax receipts, this prevents the interest rate in those countries from rising along with the one in the home country. Owing to the impulse in period two, at home expected nominal demand goes up, stimulating investments, notwithstanding the higher interest rate level. Only when exports from outside countries to country one start to grow does the nature of the demand oriented policy again turn to 'supporting'.
In later periods, when the interest rate differential between the respective countries as described above has grown to a certain extent, the policy becomes counterproductive for the initiating country, whereas outside countries benefit. The home country, with its continuously rising rate of interest, experiences a negative influence on its investment activity, and consequently on its production and employment level, whereas the outside world, thanks to the 'subsidization' of their governments, observes an upward shift in investments, production and employment.

b. A monetary expansion

Assumptions: monetary sector, ICM, unilateral impulse, fixed exchange rates

As seen, the interest rate continuously rose, both absolutely and relatively, in country 1 when it expanded its material government expenditures. If it increases its money supply, its interest rate will continuously fall. The reason given above is mirrored in this case. See Table 4c.3.

In the impulse period, due to the lower interest rate, 'our' holdings of outside bonds rise and 'outside' holdings of 'our' bonds fall, both relative to V1 and V2, respectively. As a result, country one's capital account shows a deficit. In all countries net investment decisions are taken because of the fall in interest rates. Hence, on the short run the monetary policy is expansionary not only in the initiating country, but also in the outside world. This also held in Table 4b.7 where no mobility of capital was assumed. In that table, in the long run, this one time open market operation was ineffective.

But now, in the subsequent periods, countries 2, 3 and 4 pay interest to wealth holders in country one (see KOB1), who, in their turn, pay taxes on those receipts to their government. That is why the government deficit in the initiating country falls more sharply in period two, when compared to the no-mobility-case, although its interest payments (OG) fall to the same extent. The lower deficit forces the interest rate down further in country one. But in the remaining countries the deficit is enhanced forcing the rate of interest back up again.

The respective movements in the interest rates are responsible for the continuous expansion of the capital stock at home, and the relatively stable one in the outside world. In period 200 a situation has developed where in the home country labour is the bottleneck for production expansion,[44] the government runs a substantial surplus (not only due to low transfers, but especially to positive interest tax receipts combined with low interest payments) and the interest rate is nearly zero. The latter is caused by the low need of funds by the government. As a result the demand for bonds issued in 1, both by country one and by the other countries, is at its minimum level relative to wealth (2% of V1 and 1% of V2, respectively).

In summary, whereas in the short run the monetary policy is 'supporting', its effects on the outside world are mitigated as time goes by. Its impact on the initiating country, on the other hand, grows over time up to the point where labour is fully utilized. Without capital mobility (Table 4b.7) we concluded that in the long run all real impacts disappeared.

c. An increase in the wage rate

Assumptions: monetary sector, ICM, unilateral impulse, fixed exchange rates

If the unilateral action consists of a wage impulse in country one, during the first periods the real sector of the economy behaves very much as if capital was not mobile (compare the present Table 4c.4 and Table 4b.5). The monetary variables react similarly, albeit that in those periods, owing to the mobility of capital, the interest rate differentials are smaller now.

In the longer run, however, the mechanism described above starts widening the gap in the respective government deficit and interest rate developments. The higher government deficit in country one (as in Table 4b.5 caused by higher transfer payments) is partly financed by an import of capital, causing a deficit on the service account in all periods after t = 2. This way, country one's government subsidizes the governments elsewhere. This is illustrated in period 10 by 00 in both countries: interest receipts in country one are lower than without capital mobility, whereas in the outside world they are higher. Given taxation rates, the same holds for interest tax receipts. In the longer run (period t = 200), the government of the home country runs a substantial (and growing) deficit, while in the other countries they run a (growing) surplus. As a consequence, interest rates are higher than initially in country one, and lower elsewhere. The latter facilitates an expansion of the capital stock in those countries. As a consequence, labour has become the bottleneck in the outside world. In the wage increasing country, however, due to the divestments invoked by higher capital costs, the resulting unemployment exceeds the one in Table 4b.5. Once more, one should be prudent, however, in interpreting period 200 as an indication of the long run outcomes.

d. Supply-side policy

Assumptions: monetary sector, ICM, unilateral impulse, fixed exchange rates

As promised in Section 4B, we will now address the consequences of supply-side policy in the sense of a reduction, in country one, of the tax rate on profits and interest receipts, T_R. See Table 4c.5. Initially, the impact is only to be found in the monetary sector of the economy. On the one hand, the government deficit in country one rises due to less tax receipts. On the other hand, since a smaller fraction of interest proceeds is taxed away, wealth in the home country rises faster, causing its demand for all bonds to rise. These two forces have an opposite effect on the respective interest rates.

Regarding the first trend: as the higher deficit is partly bond financed, interest payments by the government rise more than without interventions. Since part of these extra interest payments are cashed (and taxed) abroad,

a development similar to the one observed above, can be expected. Indeed this pattern is indicated by the first periods included in Table 4c.5.
Regarding the second: the part of the extra wealth invested in bonds issued outside the home country sets a reversed trend in motion: interest received in the home country and paid by other countries' governments. Although relatively weak in the beginning, this second trend grows in importance over time: interest receipts are added to wealth and again partly invested abroad. See the continuously negative capital account in country one and the consequently positive and faster growing service account.[45]

Consequently, by period 200 the government in the home country runs a substantial surplus which is mainly a result of high interest tax receipts. Seemingly this is in compliance with the Laffer hypothesis (a lower tax rate leading to higher tax revenues). The reason, however, is not so much a spur of growth, although as a consequence of the government surplus the interest rate is very low causing the capital stock to grow. Far more, as stated above, the higher tax revenues are paid by the governments in the outside countries who by that time run a substantial deficit. The latter causes outside interest rates to be relatively high, and as a consequence, the capital stock, and production and employment, have fallen in those countries.
As in the short run production and employment are harmed in the home country and stimulated in the rest of the world, whereas in the longer run the opposite is observed, we can in that sense conclude that, given fixed exchange rates, a policy of profit tax reduction can be regarded as conflicting.

e. A devaluation

Assumptions: monetary sector, ICM, unilateral impulse, fixed (but adjustable) exchange rates
Before turning to flexible exchange rates, let us look at the 'mixture' between the two, a devaluation (by country one) in a system with 'pegged but adjustable rates of exchange'. See Table 4c.6.

In the impulse period, the (unexpected) devaluation results in a surplus on all parts of the balance of payments. Obviously, the trade balance is in surplus for traditional reasons. The capital account is in surplus for reasons given when describing the bond demand equation (2.27-2.28). A devaluation cet. par. implies that foreign wealth owners are richer now, in terms of currency one. If they desire to spend x% of their wealth on bonds issued in country one, in currency one this increases 10% in value after the devaluation. This is reflected by the increase in OVD21.[46]
Finally, the debt service account is in surplus as interest receipts from abroad by wealth owners in country one (calculated as last year's holdings of foreign bonds times the price of one foreign currency) increase 10% in value as well.[47]
Moreover, the latter implies that government interest tax receipts increase by 60% (the tax rate) of that gain. After allowing for more expensive material government outlays, the government deficit is still lower than without devaluation. (If fewer foreign bonds would have been kept in the portfolio, the absolute gain for the government would have been lower.)
Finally, due to increased wealth in the home country (the value of 'outside' bonds in portfolio rises by the devaluation percentage), total wealth rises which, together with the smaller government deficit, forces the home interest rate down.
Meanwhile, in the real sector, exports increase, as a consequence of the improved competitive position, forcing expectations with regard to demand and output prices up, which in turn stimulates investment decisions.
In the outside world, as can be expected from a typically switching device such as a devaluation, exactly the opposite is obtained. Interest proceeds fall below their trend level, pushing the government deficit up. Together with the smaller demand for their bonds by country one (see above), this accounts for the higher interest rate. Obviously, the cut in demand is followed by divestments.

Basically, these developments in period two set the trend for the subsequent rounds. Special attention needs to be paid here to the debt service account. The capital account surplus in period two in the home country at

initial exchange rates could be expected to be followed by a service account deficit in period three. It should be remembered, however, that 'KAB_i' as well as 'KOB_i' are defined in the currency of the 'money-importing' country, i, whereas OVD_{ij} was defined in currency j. Now in period two, at given interest rates, a 10% increase in the home-value of assets in the portfolio of country i and denominated in currency j (due to a devaluation) will lead to a less than 10% increase in total wealth in i, and therefore to a less than 10% increase in the demand for all assets when calculated in currency i. Since foreign assets are now priced 10% higher, home demand for foreign assets in currency j falls by less than 10%. And as their nominal yield (in the next period) in currency i rises by 10% (compared to the starting position), on balance the service account of country one in period 3 is positively affected. In the table (and taking into account changes in the rates of interest): the number of bonds held in 1 issued in 2 in t = 2 equals $OVD_{12} \times r_2 = 2.9879$ (rounded), which by definition equals their (money) yield in currency 2 in period 3. In home currency (currency 1) this equals $2.9879 \times 1.1 = 3.2867$. Total interest receipts (out of 2, 3 and 4) equal $3 \times 3.2867 = 9.8601$. Interest payments by the home country in that same period (3) equal $(OVD_{21} \times r_1) \times 3 = 9.5728$ (rounded). The balance on its service account therefore equals $9.8601 - 9.5728 = 0.2873$ (> 0) in period 3.

Also in period 4 the service account maintains its positive balance, which is caused by the capital flight from the home country obtained in period three. A further devaluation is expected in that period: as indicated in Chapter 2, expectations with regard to exchange rates were assumed to be extrapolative.

These international interest payments and their taxation, together with the respective developments in transfer payments (falling in the home country and rising abroad) initiated by investments, explain the falling trend in the government deficit at home and the rising one abroad. In period 200 a situation results where in the home country, due to a government surplus, interest rates are very low, with demand for bonds issued in 1 at about their minimum level. These low interest rates have facilitated

an expansion of the capital stock up to the moment where labour has become the bottleneck for production.
In the outside world, although the government deficit has substantially grown, the interest rate is on balance only mildly affected, probably due to the preference of portfolio investors for the higher interest countries. The on balance slightly unfavourable developments in their capital stock is consequently more likely to be caused by the 'real' consequences of the devaluation: the expenditure switch.

Section 4C.2. Freely floating exchange rates

This section describes (in chronological order):
a. an expansion of material government expenditures;
b. a monetary expansion;
c. supply-side policy;
d. wage policy.

a. An expansion of material government expenditures

Assumptions: monetary sector, ICM, unilateral impulse, flexible exchange rates
The results of a unilateral expansion of government purchases under conditions of floating exchange rates are listed in Table 4c.7. The immediate effects are dominated by the consequences in the monetary sector.
Due to the impulse, the home rate of interest rises, as the extra expenditures are partly bond financed. The higher interest rate attracts foreign capital : the capital account is in surplus causing the home currency to appreciate. As explained in the final part of the previous section, this invokes a deficit on the debt service account (interest receipts value less now in home currency). Obviously, the trade account also displays a shortage (exports are harmed by higher output prices and the appreciation). In the real sector profits rise (a higher output price level and about constant costs), as well as nominal demand, both actual and expected. This facilitates an increase in net investment decisions.

In the outside world, the flow of funds into country 1 forces the interest rate (marginally) up, but this does not prevent positive net investment decisions. The latter are positive as a consequence of higher export demand (by country 1).

In the subsequent period (t=3) the need of funds by the home government falls mainly as a result of higher profit tax revenues. Although this fall outweighs extra funds necessary to finance increased investments, the total "financing need" still exceeds the one without intervention. Nevertheless, the rate of interest returns to about its initial level: as the previous appreciation of the currency creates an expected further appreciation in t=3, supply of funds increases, which is reflected in an even higher capital account surplus. As a result, the interest rate at home falls, whereas the one abroad rises.[48]

So far, the monetary sector dominates the exchange rate development. But in period 4, where expectations of appreciation are moderated due to the way expectations are formulated and where especially in the home country the stock of capital starts expanding, the real sector gains importance in this sense. Induced by higher employment, labour income in the home country rises (and with it nominal import demand grows), leading to a depreciation of home currency. The trade account is "helped" in this respect by the shortage on the debt service account caused by previous influxes of capital.
The resulting depreciation will gradually eliminate the expected appreciation and thereby the capital import into country 1. From period 7 onwards the exchange rate developments are dominated by the service account. The still negative balance on that account leads to depreciations invoking a still moderate capital flight out of country 1 from period 9 onwards. By period 10 the shortage on the capital account outweighs the (decreasing) deficit on the service account. The vicious circle between exchange rates and the capital account becomes visible : a depreciation calls for an expected further depreciation, a consequent capital outflow, a further depreciation, and so on.

At the same time the table demonstrates the "break" in this circle (see period 200). The capital outflow leads to a growing service account surplus. At the moment the latter exceeds the outflow of capital, the circle is broken and an "appreciation - capital inflow" circle starts, as soon as the appreciation leads to an expected appreciation.[49]

All of these considerations, however, do not seem to have a large impact on the nature of the adjustment process in the real sector as traditionally depicted. By period 200, fiscal expansion has led to an increase in production and employment in country 1. Production in the other countries is at a (albeit slightly) higher level, too. Once more, however, period 200 cannot be regarded as the ultimate long run outcome.

b. A monetary expansion

Assumptions: monetary sector, ICM, unilateral impulse, flexible exchange rates

If the government of country 1 decides to pursue a (one time) open market operation, not surprisingly the resulting influences on interest rates and rates of exchange are largely determined by monetary factors. Table 4c.8 provides the results of a purchase of 1 % of outstanding bonds in period 2.[50] In the impulse period, in an effort to restore portfolio balance, country one's inhabitants ask for more bonds (of all origins) and capital is exported to the rest of the world. As a result interest rates in all countries fall, but especially in the home country. This causes the home currency to depreciate, and as a consequence the trade balance as well as the debt service account are in surplus. As an immediate side effect of the latter, interest tax receipts in the home country rise (incoming interest payments are valued higher in home currency), whereas those abroad fall, causing the home government deficit to fall and the one abroad to rise, widening the international interest rate differential.

Meanwhile, in the real sector, the trade balance surplus in the home country is reflected in higher nominal export demand and consequently higher expected output prices, inducing positive net investment decisions. By the same token, in the outside world decisions are taken to reduce the capital

stock. This way, in the short run, monetary policy can be labelled "conflicting" here.

In period 3 the service account shows a surplus caused by the previous capital export. This forces the exchange rate down (appreciation), which serves as a cause of a shortage on the capital account. This deficit is enhanced by the expectations of a further depreciating currency.[51] As time goes by, the latter is of less influence which shrinks the shortage on the capital account over time. Still, during a number of periods the capital account stays negative. As a result the service account grows and the currency gradually appreciates. In period 9 the home currency has even on balance appreciated, causing the trade balance to show a deficit. Obviously, the appreciation hampers future output expansion.

Even before that time, as a consequence of the capacity effect of investments, output prices have fallen which discourages new net investments.

In the outside world, the opposite effects are obtained. When net investments in country 1 are positive, entrepreneurs abroad decide to shrink their stocks of capital, and vice versa.

So, during the period of adjustment towards a new equilibrium, the monetary policy is conflicting. As stated before, the new long run position itself is not found in the table.

c. Supply-side policy

Assumptions: monetary sector, ICM, unilateral impulse, flexible exchange rates

Table 4c.9 provides an insight into the consequences of a reduction of 5 % in the tax rate on interest receipts and profits.[52] The tax reduction enhances the growth in wealth in the home country. A part of this larger wealth is invested abroad, which creates a deficit on the capital account. With exchange rates flexible, this calls for a depreciation of the home currency. This has positive effects on the capital account itself, for the service account and, more importantly, for the trade account. The increase in exports positively influences expected demand and expected output prices. As the latter more than compensates the rise in expected capital

costs (caused by the higher interest rate that is invoked by an increased government deficit), the immediate effect on investment decisions is now positive. In Table 4c.5, assuming fixed rates of exchange, the rise in exports was not obtained and as a result expected output prices did not rise. In that table investment fell, which could be attributed to the rising rate of interest in the first period.
Returning to Table 4c.9, this positive trend in the real sector is set forth for a number of periods. As a result of higher demand (exports, investments and later on consumption due to increased employment) expected demand keeps growing, furthering the rise in expected output prices. Of course, this trend is slowed down by the capacity effect of investments themselves. But later on, the developments in the monetary sphere gradually dominate this reversal: the continuous expansion of wealth each period is partly invested abroad giving rise to continuously rising interest receipts. A growing surplus on the service account is the result, dictating the currency to appreciate. This harms exports, output and employment. As a consequence, the government deficit rises. Moreover, right from the beginning the government ran a higher deficit as a result of lower tax receipts. This deficit (partly financed by foreign portfolio investors) rises as a result of higher financing charges. So, the government, financing its foreign "colleagues" ends up with a large and growing deficit, which forces the rate of interest up and investments down, etc.
Again, in the longer run the service account appears to dominate the picture.

d. An increase in the wage rate

Assumptions: monetary sector, ICM, unilateral impulse, flexible exchange rates

In the impulse period an increase in the wage rate -see Table 4c.10- leads to higher imports and lower exports along lines familiar by now. Because of the falling exports nominal output prices rise by less than the impulse percentage. As a consequence, expected real wage costs rise and entrepreneurs decide to divest.
Given flexible exchange rates, the changed consumer behaviour causes a depreciation of the home currency, leading to a positive balance on the

service account as well as on the capital account. The influx of capital explains why the rate of interest in the home country falls (and rises abroad) although the government deficit has grown, due to higher transfer payments and nominal government purchases.

In the next period, the government deficit in the home country rises further, mainly as a result of lower profit tax receipts: the wage increase led to negative profits in period 2. In the outside world, where period two's profits were positive as a result of the rise in demand for their products, the opposite happens: a lower deficit and hence a lower rate of interest. The international interest rate differential turns positive now for the home country. But after correction for the expected depreciation of the home currency this differential grows in favour of the outside world and can therefore not explain the capital inflow. The latter is explained, however, by the further depreciation. Although investments in the home country fall now and due to their demand effect output prices fall invoking exports to go up, the currency depreciates further, which is explained as follows. In period 2 the home country imported capital. As a consequence, if the exchange rate had been fixed, one would expect a deficit or anyway not a large surplus on the service account in period 3. However, a relatively large surplus on the capital and on the service account is needed to counterbalance the still large deficit on the trade account. These surpluses are invoked by a depreciation. As a result of that depreciation the value of incoming interest receipts rises in home currency improving the balance on the service account. The same depreciation also improves the balance on the capital account. This argument is illustrated by the values of the respective balances that would have been obtained if the exchange rates of period 2 would have applied: S1N' = 0.67258, KOB1' = 0.01344 and KAB1' = 0.13601.[53]

In period 4 the interest rate differential is even more favourable for the outside world (after correction for expected exchange rate developments). Nevertheless, for the same reason as above, the capital account of the home country is still positive.[54] But this circle does not continue forever. The deficit on the trade balance falls (even without the depreciation[55]) as a result of a smaller demand for imported products, which is caused by growing unemployment. After a few periods the depreciation

needed to achieve the necessary equilibrium in the balance of payments is so small that the service account can turn negative (here in period 7). Meanwhile, in the real sector as a consequence of the disinvestments, prices in the home country have gone up and profits are positive again. The part of these profits that is taxed away attenuates the growth in the government deficit. The other part, added to wealth just as the relatively high interest earnings, cet. par. increases the demand for bonds.[56] In period 9 this results in a decline in the home rate of interest which, together with the declining expected rate of depreciation, discourages capital import (by that time still positive, however).
In the outside world, where profits are smaller each period since t=2, at about the same time interest rates are rising.
This complex of factors (falling interest rates at home, smaller depreciations and thus expected depreciations of the exchange rate, rising interest rates abroad) will in a certain period cause a capital outflow. The table displays the situation in period 200: the capital outflow causes the service account to be positive, calling for an appreciated currency which in turn leads to a deficit in the trade account, reflected in high imports and low exports. The small exports imply a low demand (output) with clear implications on investments.

In this sense, with international capital mobility and floating currencies, in the longer run the exchange rate developments, dominated by a surplus on the service account which leads to an appreciated home currency, aggravate the unbeneficial influence of a wage rise on home production and employment via their disadvantageous impact on exports. The same exchange rate development benefits foreign exports, output and employment.

Appendix 4.1 A summary of the starting position in t = 1 if a monetary sector is included

Companies

$Y_L = \ell_m \times P_L = 100 \times 0.8 =$	80	$C = c \times P_y = 60 \times 1 =$	60
$\delta k P_y = 0.1 \times 100 \times 1 =$	10	$G = 14 \times 1 =$	14
$O_p - B = 11 - 1 =$	10	$I = 10 \times 1 =$	10
$Y_R =$	0	$X = 16 \times 1 =$	16
	100		100

Households

C	60	Y_L	80
M	16	TRF	20
BT	0		
BL	24		
	100		100

Entrepreneurs and Wealth owners

$T_R \times 00 = 0.6 \times 15 =$	9	00	15
$T_R \times Y_{R_{-1}} =$	0	$Y_{R_{-1}}$	0
savings	6		
	15		15

Government

G	14	B_L	24
0G	5	BT	0
TRF	20	BR	9
F	- 6		
	33		33

Bonds market

Extra supply of bonds:		Extra demand for bonds:	
$\frac{1}{2}(-F)$	3	$\frac{1}{2}(\Delta V)$	3
I	10	$\delta k P_y$	10
	13		13

NOTES (Chapter 4)

1 The same central proposition will be made in case of substitution. But in that situation, the proposition will have different inferences, see Chapter 6. The hypothesis in this chapter is (with modifications) based on Freia, one of the models of the Dutch Central Planning Bureau (CPB), in 'FREIA, Een Macro-Economisch Model voor de Middellange Termijn', CPB Monografie nr. 25, The Hague, 1983, pp. 30-37.

2 This formulation implies net (as opposed to gross) investments to be dependent on expected profits - an assumption similar to (3.6). Theoretical considerations would favour gross investments, however. See F.Scotland, 'Investment: A Survey of Models with Some Implications for the Effects of Monetary Policy', Technical Report 29, Bank of Canada, Dec. 1981, p.17. But such a hypothesis has serious didactic drawbacks: investments would vary sharply with heavy inferences on prices, consumption, etc. Since also empirically such sharp fluctuations in investments are not observed, we will stick to the formulation in the main text.

3 In Chapter 2, it was assumed that expected interest rates equal present interest rates throughout. The same holds for expected tax rates.

4 This coincides with the calculation of Y_R in equation (2.23).

5 This discount factor coincides with the one used to get the market value of a bond. See Appendix 2.3. If no monetary sector is included, the third term as well as the discount factor disappear from (4.1).

6 Analogous to the definition of the real interest rate, one might consider substracting expected inflation from the term in brackets. Since entrepreneurs were assumed to invest possible profits in bonds and not buy consumer goods or machines, for example, (4.2) is formulated without this price increase.

7 The idea of explicitly combining profit expectations and demand expectations as determinants of investments is not only found in Freia (see footnote 1 above) but also in Eisner, e.g., (see Eisner, 'Factors in Business Investment', NBER, Ballinger Pub. Co., 1978, Chapter 4). In the more traditional investment hypothesis of Chapter 3 this mechanism plays an implicit role: given a difference between output prices and costs per product, the profit (and hence net investment) will be smaller (cq. more negative) if capital is underutilized.

8 With given tax rates under the assumption that capital is expected to be the bottleneck for production expansion. See (4.2) and (4.3).

9 The similarity between the respective chapters is contained if the same instrument was used with exchange rates floating freely. Here investments do not change since output prices (actual and expected) rise to the same extent as labour costs (actual and expected, resp.). Compare Tables 4a.5' and 3a.9.

10 If no monetary sector is included.

11 In Table 3a.11 net disinvestment decisions in t = 2 equal those in t = 3, due to the fact that the actual capital stock is the same in both periods. This is not the case in Table 4a.7.

12 That is, before volumes of production and employment are changing.

13 'Home consumption' refers to 'consumption of goods produced in the home country'.

14 Not out of country one, since those goods were relatively more expensive.

15 To save space, in Tables 4a.11, 4a.12 and 4a.13, only the variables are listed with regard to the countries one and four. The outcomes for country two equal the former, while the ones for country three equal the latter.

16 The only harm done to those countries is caused in the impulse period. Due to higher product prices in the block countries, the price of imports into the outside world and thus their price level of private final absorption is increased, causing a slightly lower real level of that absorption.

17 As explained, this is mainly caused by the exclusive short term relationship between imports and the price level of those imports. In the longer run exports to the block countries (and production in the outside world) even increase, because of the growing consumer demand in those countries.
Note that the definition of "welfare" used in the SIER-game differs from the one traditionally used in customs union theory.

18 This conclusion is supported by empirical studies estimating trade creation and trade diversion in the EC: trade diversion, unlike trade creation, can hardly be traced.

19 Cooper and Massel, 'A New Look at the Customs Union Theory', in P.Robson (ed) 'International Economic Integration, Selected Readings', Harmondsworth, 1972, pp. 91-98.

20 Being $\frac{1}{1+\varepsilon}.BT$ or $\frac{1}{1+\varepsilon}.t.M.P_y$. The remainder of BT is used to finance extra imports.

21 The reader is reminded that 'welfare' in neo-classical trade theory is measured differently.

22 Note the 'purely switching feature' of import tariffs in Table 4a.12': what the block gains in production is lost by the rest of the world. The feature also exists in Table 4a.13, for instance, but, due to the 2 by 2 division, it is shown more clearly here.

23 Remember that without redistribution the volume of imports cq. home consumption only depends on the price level of the product concerned.

24 A positive rate of interest combined with zero real growth and an initial government deficit partly bond financed implies a continuous increase in the government deficit and in government debt. This ingredient of the game teaches players that in such circumstances policy measures are needed to make sure the government deficit does not run out of hand.

25 To fix the capital stock at 100, gross investments are 10 (as opposed to 20). To keep spending at 100, material government expenditures are 14 (as opposed to 4).

26 Recall from Chapter 2, that V_i, OO_i, OVD_{ij} and O_{ij} relate to wealth-owners and entrepreneurs (i.e., private persons), whereas O_i relates to the total stock of bonds (including bonds held by firms).

27 We assume that when starting the game, interest paid and interest earned by firms are 'cancelled out'. Interest proceeds by firms are taxed together with Y_R.

28 Since initially in a model with monetary block material government spending equals 14, a 10% increase now equals 1.4. In Table 4a.2 the same impulse came down to a 0.4 increase in G. This means that the respective tables are in this sense incomparable. In addition, if the impulses had been of the same absolute magnitude (i.e., if the present impulse would have been 0.4/14 = 2.87%, the results would still be incomparable since, among other things, the life span of machines is now 10 years (instead of 5 years).

29 Just as in the no-monetary-sector case, welfare in the short run is hampered by the impulse, whereas in the long run, due to higher employment and private absorption, it is higher.

30 'ICM' stands for the International Capital Mobility as described in Chapter 2.

31 Foreign interest rates seem to be stationary in Table 4b.3, but this is due to rounding. Abroad, interest rates fall as can be verified by comparison of V2 and OO2 in Tables 4b.1 and 4b.2 (V2 rises and OO2 falls). See also r2 in period 10 in Table 4b.3.
The assumption made in Chapter 2 that the monetary consequences of trade balance disequilibria are neutralized, prevents an influence of the foreign trade surplus on their rates of interest.

32 Remember that depreciation was assumed to occur at replacement value, whereas financing charges were calculated over actual borrowings.

33 Since the life span is doubled, implying a longer time horizon for expectations, for example, the impacts are not equal in a quantitative sense.

34 Alternatively, one could raise government expenditures as in Section 4A, for instance.

35 This will, among other things, produce a decrease of the future interest payments by the government concerned. Since, when formulating the

equations, we assumed the Central Bank would purchase (or sell) only government bonds, there should be enough government bonds held by the public. Consequently, the limits between which monetary expansion (and contraction) are allowed in the game are smaller than the 10% discussed here.

36 Whereas in the tables regarding a one time open market operation, both r and P_y return to their initial values, now with a change in $\bar{\alpha}_1$, both P_y and r rise. In both cases the long run equilibrium condition $(1-\delta-r)P_y = P_L$, where $\delta = 0.1$ and $P_L = 0.8$, is satisfied. Moreover, in all tables concerning monetary impulses, the initial drop cq. rise in interest rates is not overwhelming if compared to the size of the interventions. Didactically, a more impressive reaction of interest rates could be desirable. I tried to accomplish that by lowering the sensitivity of bond demand to changes in the interest rate. As this complicates the formulation of the bond demand equation and the results differed only marginally, I left the coefficient concerned at 5.

37 Both tables refer to world-wide impulses.

38 In tables, no suffices can be used. So, 'BR', for example, should be read as B_R.

39 Since we assumed 'eternal' bonds, a mistake in one period will have its impact in all periods to follow.

40 To illustrate this point: without interventions, in period 859 the holdings of bonds by subjects in country one, issued in their own country, reach the minimum level set in the bond demand equation, due to the international interest rate differential.

41 Obviously, the other three governments are also 'subsidized' in this respect by firms in country 1 that borrowed capital from abroad. For ease of explication, if this mechanism applies we speak of only governments subsidizing each other.

42 Shown in the table as an increase in both OVD_{11} and OVD_{21} and a decline in OVD_{12} and OVD_{22}, all relative to the portfolio concerned. The flight into country one's assets is also at the expense of assets issued elsewhere: see the relative fall in OVD_{23}.

43 The rise in interest rates cumulated over all countries, equals the rise in the 'home' rate without mobility of capital (see Table 4b.3): the increased need of funds is now met world-wide, whereas in Table 4b.3 it is to be met in the home country only.

44 Causing zero net investments.

45 To illustrate this point further, in Table 4c.5' one finds for the same intervention the time interval during which the government deficit switches from rising (due to the first trend) to falling (due to the second), whereas in the outside world the deficit keeps rising. Furthermore, this table highlights the crucial role of interest proceeds in country one (001).

46 The same phenomenon is reflected in the fall of OVD12, a figure denominated in currency 2. Measured in home currency, this figure actually rises.

47 The difference between the figure concerned (001) in the present table and the one in Table 4c.1 equals 0.6 (share of foreign in total bond holdings) × 15.3 (interest receipts with no intervention) × 0.10 (impulse).

48 Country 1, with its lower rate of interest is more attractive to portfolio investors than the other countries once expected exchange rate developments are taken into account. In period 3 the home currency appreciates further. Defining S1N' as the trade surplus of country 1 if exchange rates would equal those of the previous period, and defining KOB1' and KAB1' analogeously, in t=3 S1N'= -0.09064, KOB1'= -0.06683 and KAB1'= 0.19657. In t=4: S1N'= -0.10287, KOB1'= -0.08734 and KAB1'= 0.01469. These figures are not included in Table 4c.7, but were calculated separately.

49 Of course, this reasoning only holds "cet. par.", i.e., given interest rates for example.

50 The impulse here amounts only to 1 %, as opposed to 10 % in comparable previous tables. The reason is that at the required level of accuracy (11 digits) and using the present model (592) the effects of a 10 % monetary impulse could only be calculated for 30 periods. In Chapter 6 an alternative model (597) is used to overcome this problem. Using model 597, in Table 7.4 (Chapter 7) some results are shown for a 10 % monetary expansion under the present assumptions.

51 Remember, that currently expected exchange rate developments were assumed to be a function of previous exchange rates.

52 Again, using model 592 an impulse of -10 % could not be calculated for a sufficient number of periods here. This complicates a quantitative comparison with Table 4c.5. A qualitative comparison, however, remains possible.

53 Although in period 2 a capital influx was reported, KOB1' in period 3 is nevertheless positive. This is a result of the high interest rate in the outside world if compared to the one at home, as well as of the fact that interest earned abroad is worth a lot in home currency because of the high price of foreign exchange.

54 In this period KOB1' = 0.01454 and KAB1' = 0.19924.

55 In t=4 S1N' equals -0.57737.

56 Wealth (defined in home currency, see Chapter 2) also rises as a result of the continuous depreciations.

Chapter 5 Substitutable factors of production, investments determined by lagged profits

This chapter contains:
Section 1. Introduction: the new equations, the global adjustment process.
Section 2. Adjustment processes
Section 3. An illustration of the model: some simulations

Section 1. Introduction

In the previous chapters complementarity between the factors of production was assumed. On the one hand this implied that, given the amount of (fixed) capital available on the short run, production could not be expanded [1] even if labour was ample. On the other hand, prices of labour and capital were not relevant to the production technique chosen, since by definition only one technique was available.
In this and the next chapter we will study consequences of introducing possibilities of substitution between the factors of production. The consequences with regard to cost minimization, however, are postponed to the next chapter, Chapter 6: the difference between Chapters 5 and 6 concerns the assumed investment behaviour. In the present chapter, as in Chapter 3, investments are taken to be determined by lagged profits, irrespective of expected relative prices of labour and capital. (For the theoretical foundation, the reader is referred to Chapter 3.) This simplification is abandoned in Chapter 6.
Production in both this and the following chapter is determined by the volume of labour and capital available via a Cobb-Douglas production function:

$$y_s = \beta_0 \, l_m^{\beta} \, k^{1-\beta} \tag{5.1}$$

with the parameters:

$\beta_0 = 1$ [2]
$\beta = 0.8$

y_s refers to the number of goods produced and supplied.
(5.1) combined with the assumption of profit maximization under perfect competition results in the short run macro-economic supply curve, which is derived as follows.

Profit maximization implies

$$P_y = \frac{\delta \ell_m}{\delta y} P_L \tag{5.2}$$

where the first factor on the right hand side follows when (5.1) is rewritten as

$$\ell_m = y^{1/\beta} / k^{\frac{1-\beta}{\beta}} \tag{5.3}$$

hence, $P_L \frac{\delta \ell_m}{\delta y} = P_L \frac{1}{\beta} \; y^{(\frac{1-\beta}{\beta})} \quad k^{-(\frac{1-\beta}{\beta})}$

Combination with (5.2) leads to the short run supply curve

$$y = k(\frac{P_y}{P_L} \beta)^{\frac{\beta}{1-\beta}} \tag{5.4}$$

For given k (short run) and β, (5.4) can be rewritten as

$$\dot{y} = (\frac{\beta}{1-\beta}) (\dot{P}_y - \dot{P}_L) \tag{5.4}'$$

(5.4)' clarifies the shape and "validity" of the supply curve, and is the formulation found in Marston, for example. [3] Nevertheless, it is not the equation used by the computer, since it assumes k to be constant whereas over time k can change. As long as ℓ_m is flexible, (5.4) is used as the (rising) supply curve. [4] In the game, the outcome of (5.4) is labelled y_s. However, if ℓ_m has reached its upper limit (total labour supply minus the number of civil servants), the supply curve becomes a vertical line at

$$y_{max} = (\ell_s - \ell_g)^{\beta} k^{1-\beta} \qquad (5.5)$$

In the computer model, y_{max} is referred to as 'cap'.
So, as in the previous two chapters, the supply curve, as depicted in Diagram 5.1, is kinked with the "non-vertical" part at marginal cost level.

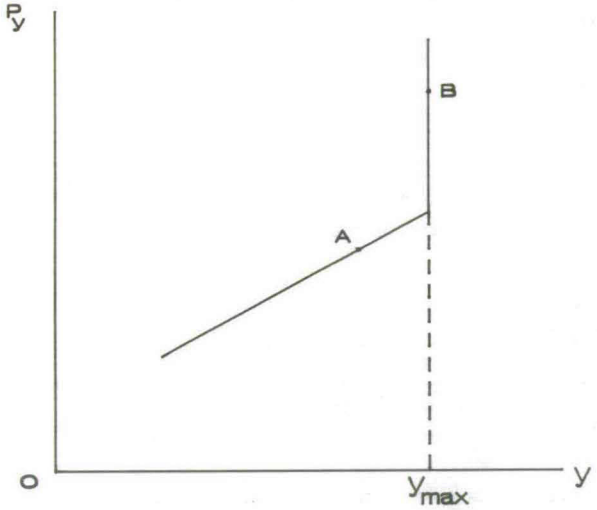

Diagram 5.1

Main differences between the respective kinked curves are, however:
- in the present situation marginal costs are rising as long as production is below its maximum level, whereas with complementarity marginal costs were constant in that situation;
- the 'kink' in Diagram 5.1 is due to the bottleneck labour, whereas with complementarity it was either caused by the bottleneck labour or by the bottleneck capital;
- if, with complementarity, the bottleneck was labour, accumulation of capital could not shift the kink to the right, whereas in the present situation it can.

Other differences between the "complementarity-model" and the present one can be summarized as follows.

The initial stationary situation (with about 3% unemployment, see Chapter 3) is now reflected by A on the 'non-vertical' part, whereas it used to be located on the vertical part of the supply curve. The difference is explained by the different production functions. In Chapters 3 and 4 full capacity output was reached as soon as either labour or capital was short, but in the current chapter as well as in Chapter 6 this level of output is obtained only if no extra labour can be hired.
The point of equilibrium on the product market is calculated slightly differently now:

$$P_y = \frac{Y}{y_s} \quad \text{or} \quad P_y = \frac{Y}{y_{max}} \qquad (5.6)\ ^{5}$$

A further distinction from the complementarity-case lies in labour productivity. Whereas in the previous two chapters it was constant (by definition), it now varies along the supply schedule. This is reflected in the wage equation where the game leader is allowed to let wages depend on labour productivity [6] growth.

The model with substitution also differs from the one with complementarity with respect to private labour demand. Labour demand by the private sector, ℓ_m, used to be a linear function of business output. With substitution, ℓ_m depends on y_s as well as on the amount of capital, if the supply curve is upward sloping, since then fixed capital will always be fully employed. If the economy's situation is reflected by a point on the vertical part of the supply curve (labour is scarce), ℓ_m is calculated as the difference between total labour and the number of civil servants.

A final distinction is found in the endogenous variable "model". When assuming complementarity this variable was equal to one if the demand model applied, with demand exclusively and solely determining the volume of production, and prices solely depending on costs. "Model" equalled zero if the supply version obtained: production determined by capacity, and prices determined by the point of intersection between demand and supply.
In this and the next chapter this distinction is, strictly speaking, no longer useful, as can be illustrated by the use of Diagram 5.1 above. If the point of intersection between supply and demand is on the upward

sloping part of the supply curve -as in the initial situation A- an increase in demand will lead to an immediate upward adjustment in both prices and output. At a point like B, however, an increase in demand will on the short run only lead to higher prices. Because of the resemblance of the latter situation to the one familiar from the complementarity chapters, we will continue to indicate a situation like A by "model = 1" and the one like point B by "model = 0".

Section 2. The adjustment processes

The reasons provided in Chapter 3 not to combine the present investment behaviour with the monetary sector also apply in the present chapter, as will be illustrated below with the help of Tables 5b.1 to 5b.3. Therefore, when describing the adjustment processes we will assume that the model only contains a real sector.

Let us first concentrate on situations characterized by "model = 1" such as the starting position (point A in Diagram 5.2 [7]).

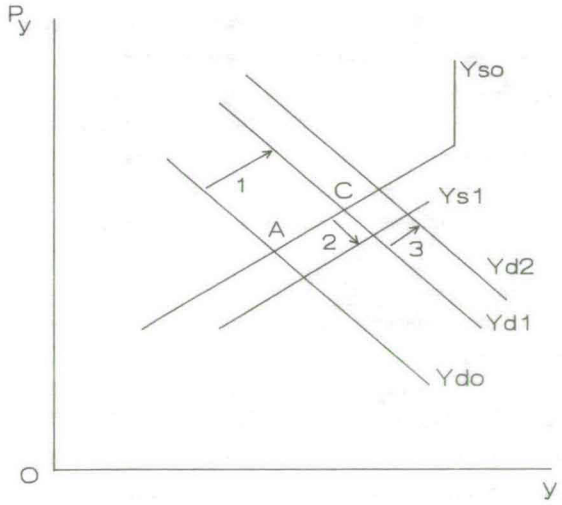

Diagram 5.2

If demand is increased by a (world-wide) **government expenditure impulse**, for instance, the demand curve shifts upward and to the right as indicated by arrow 1. The new short run equilibrium is found at C with output and production prices exceeding their previous levels. The rise in prices depresses private consumption, but since output in real terms rises as well, not to the full extent of the expenditure impulse. Due to "diminishing returns to factor proportions", short run employment opportunities expand by more than output does. As such, this rise in employment will to a certain extent offset the inflation-induced fall in consumption. [8] Meanwhile, profits grow positive, although not to the full amount of the increase in nominal output: the rise in profits is mitigated by the increase in the number of people employed as opposed to the development with complementary factors of production (see Chapter 3).

Consequently, next period's net investments will be positive, constituting a further impulse on demand (not shown in Diagram 5.2), with short run effects as described above.

Two periods after the impulse we can expect the capital stock to start growing, which shifts the supply curve (5.4) to the right (arrow 2 in Diagram 5.2). In principle one could expect two effects of an expansion of the capital stock on employment: a 'expansion effect' (positive) and a 'substitution effect' (negative). The former is invoked by a lower price level, which at given labour income increases the volume of demand, whereas the latter indicates that a given number of goods can now be produced with less labour. If the expansion effect prevails, it is enhanced by an outward shift of the demand curve caused by fewer unemployed (and thus a higher nominal household income), arrow 3 in the diagram: the employment-effect.

As shown in Appendix 5.1, an expansion of the capital stock is on balance likely to raise employment opportunities, given the price elasticity of private consumer demand (of -1) and given rigid nominal wages.

As such, the outward shift of the supply schedule will lower output prices and thereby, cet. par. profits. This reduces the incentive for a further expansion of the capital stock and hence paves the way for the model to reach a new stationary equilibrium. The employment effect, however, could in principle block this lowering of output prices. Appendix 5.1 also

shows, however, that on balance, output prices will be lowered by a growth in the stock of capital. [9]

Although in the short run the outcomes will deviate from the ones when complementarity was assumed (Chapter 3), in the long run we expect the outcomes to be identical. The reason is basically that in the long run entrepreneurs will return to the initial capital/labour ratio. This can be clarified as follows.

Initially the goods sector of the economy is represented by point A in Diagram 5.3 where for simplicity the marginal cost curves are drawn linear. P_{y_0} equals average costs (AC), profits are zero.

Immediately after the impulse, when capital is still fixed, the expansion of output (to B) is brought about by use of a more than proportionate increase in labour: $\dot{\ell}_m > \dot{y} > \dot{k}$ (= 0). Hence, the ℓ/k ratio initially rises. Profits are positive: $P_{y_1} > AC$.

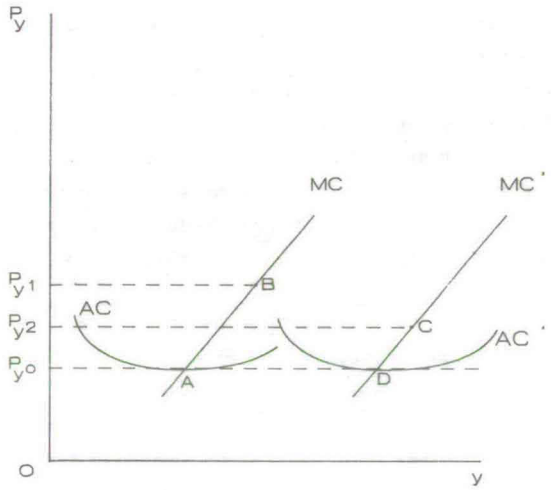

Diagram 5.3

The positive profits tempt the entrepreneurs to expand their capital stock. As shown in Appendix 5.1, this will also lead to more employment (so both k and ℓ_m rise), but the same appendix showed that the output price level will fall. The latter implies that the increase in output is smaller than the one in capital. And this, in turn, must imply that $\dot{\ell}_m$ is even smaller. Hence, the increase in the capital stock will lead to a drop in the ℓ_m/k ratio.

So, the higher capital stock, causing the set MC - AC to shift to the right, will lead to a fall in output prices (to P_{y_2} in C) and a fall in the ℓ_m/k ratio. Profits in C are still positive, but smaller than in B. Again the entrepreneurs will decide to invest in net terms.

This sequence continues until profits are zero, that is until output prices have come down to the initial level of average costs, P_{y_0}. Due to the Constant Returns to Scale feature of the production function, not only is the initial price level restored in the new equilibrium, but the same is true of the ℓ_m/k ratio: $\dot{\ell}_m = \dot{k}$. And, as a consequence, output, employment and the capital stock must in the long run have grown proportionately.

In other words, since the initial α en κ will be restored, the long run position (like in Chapter 3 reached where $Y_R = 0$) is characterized by $y(P_y - \alpha P_L - \kappa\delta P_y) = 0$ or, since in the new equilibrium $\alpha = \kappa = 1$, by

$$(1-\delta)P_y = P_L \qquad (5.7)$$

Hence, if wages are fixed, the long run output price level will be fixed as well. Meanwhile, volumes will have grown.

In summary, in the long run we expect an impulse on demand to be followed by change in supply leaving prices on balance unaffected. The difference with the complementarity-case will be found only in the short and intermediate run.

The main effects that can be expected from a word-wide **wage impulse** in the same context as in Diagram 5.2 are highlighted with the help of Diagram 5.4.

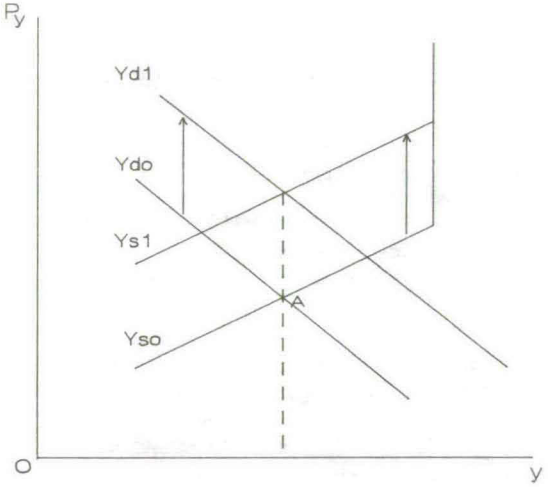

Diagram 5.4

Higher wages have two effects:

1. on the supply curve: as indicated by equation (5.4)' a wage increase shifts the supply curve upward to the same extent[10]
2. on the demand curve: since all[11] wages rise to the same extent, nominal consumer spending rises with the impulse percentage as well.

On balance, output remains fixed. The only remaining effect to be expected is a one time price increase. In terms of the long run equilibrium condition (5.7), long run prices in the intervening countries will rise by the impulse percentage.

If the wage improvement is only carried through in one country, or rather not in all countries, with fixed exchange rates, exports will in real terms fall. As a consequence, total demand and therefore production prices rises by less than that percentage, causing losses and disinvestments in the intervening countries, shifting the supply curve to the left. In a

sense, this, let us say, unilateral wage increase, comes down to its multilateral counterpart (above) plus a negative demand impulse 'at home' and a positive impulse on demand in the outside world.

In the long run we expect condition (5.7) to hold, so higher output prices in the intervening countries and on balance unchanged output prices in the outside world. But at the same time, due to the divestments mentioned, we expect an unfavourable production and employment development in the home country, as opposed to an expansion of production and employment outside, caused by an improved competitive position.
With flexible exchange rates, however, the respective competitive positions will not change: the home country's currency will depreciate by the impulse percentage to keep its trade balance from deteriorating. Consequently, just as in Table 3a.9, we expect only a wage-and-price-increase in the home country, leaving the outside world unaffected.

Investment stimulating policies (a reduction of the profit tax rate if profits are positive) can be expected to have two kinds of stimulating effects on both production and employment as far as the short and the medium term is concerned:

1. due to higher net profits, demand for investment purposes is raised, shifting the demand curve to the right
2. the faster accumulation of capital shifts the supply curve to the right at a faster rate than without tax reduction. As shown in Appendix 5.1, this can be expected to speed up employment growth. As both ℓ_m and k rise faster, production will rise faster, too. But again as in Chapter 3, the long run equilibrium outcomes will not deviate from the ones without a tax reduction.

In the '**supply-branch**', that is, if the short term supply curve runs vertically, the following effects of interventions can be expected.
A certain **expansion of demand** will lead to far higher profits. The reason is straightforward: since the supply curve is inelastic, the demand increase will for the full extent lead to higher prices, that is, to higher nominal sales. Since extra labour cannot be hired (by definition), and the Phillips mechanism is not included, the total wage bill will not rise and,

apart from depreciation charges, the rise in profits equals the total rise in sales. (This reasoning also applied to the short run situation with complementary factors of production, Chapters 3 and 4.)

This should be contrasted to the situation where the supply curve slopes upward: an increase in demand is partly met there by an increase in (real) production, facilitated by an increase in the number of people hired, i.e., by increasing the wage bill.
This steep rise in profits endangers the stability of the model: although Appendix 5.2 shows that, also in the case of a vertical supply curve, the subsequent increase in the stock of capital will cet. par. lower output prices and profits, this conclusion only holds as long as the demand effect of investments does not distort the picture. But as that demand effect (i.e., the outward shift of the demand curve due to more investment demand) is relatively large if compared to the capacity effect (i.e., the outward shift of the supply curve), prices and profits will on balance rise, invoking extra net investments and so on.
An increase in demand, causing output prices, profits and net investments to go up, will induce the vertical supply curve to shift to the right. In this sense, the economy will behave much in the same way as if the supply curve sloped upward. The main difference, however, lies in the relatively large outward shift of the demand curve destabilizing the adjustment process. This stability problem will be illustrated below.[12]

If the vertical branch of the supply curve still applies and all wages, including those of civil servants, increase, we expect the 'kink' in the supply curve to shift upward proportionately: the rising part resembling marginal (labour) costs rises, just as total demand, by the impulse percentage. As a consequence no important shifts can be expected.
If only market wages are increased, leaving wages of civil servants and unemployment benefits unchanged, the former shift (in costs) is still obtained, but the latter (in demand) is less than proportional. Depending on the initial situation, this can shift the variable 'model' back to one again, where the demand model applies. Since wage costs rise more than output prices, we expect losses, divestments, a decreasing capital stock and a further drop in employment (in line with Appendix 5.1). The decline

in the capital stock will increase prices, mitigating losses. The process halts where the long run equilibrium condition ($\dot{P}_y=\dot{P}_L$) holds.

All expectations expressed in this section will be verified in the next one, Section 3.

Section 3. An illustration of the model: some simulations

This section is subdivided into:

3A.1 Simulations without a monetary sector and a rising supply curve

1. no impulse
2. extra government purchases
3. a wage increase
4. supply-side policy

3A.2 Simulations without a monetary sector and a vertical supply curve

In this section we will manipulate impulses to obtain a vertical supply curve and discuss some impulses within that range.

3B. Simulations if the model includes a monetary sector, to illustrate that it would not be useful to combine the present investment equation with the monetary sector.

Throughout this section we assume an immediate link between prices and international trade. Given the rather extensive description of the expected adjustment patterns in the previous section, we will confine ourselves to points illustrated in the tables but not discussed in that section.

Section 3A.1 Simulations without a monetary sector and a rising supply curve

1. No impulses

Table 5a.1 gives the familiar starting position. As the chart shows, the coefficients are set at such a level that the present starting position equals the one assuming complementarity between the factors of production.

2. A government expenditure impulse

Assumptions: no monetary sector, non-vertical supply curve, world-wide impulse

Table 5a.2, showing the major results if all countries increase government purchases by 10%, mainly confirms the expectations described in Section 2. In period two the price effect on consumption outweighs the employment effect, although, with capital constant, employment grows faster than real output, as expected. Period 4 confirms the outcomes of Appendix 5.1: an increase in capital causes a (smaller) increase in output with falling prices and an again smaller but still positive effect on employment. This is repeated on a smaller scale in the subsequent periods until the new equilibrium is reached (in period 189) where capital and labour have grown proportionately to output, and prices are at their previous levels. As also expected, this new equilibrium is identical to the one in Table 3a.2, with welfare higher than without impulse as a result of higher private final absorption and lower unemployment.

Assumptions: no monetary sector, unilateral impulse, non-vertical supply curve, fixed exchange rates

Carrying out the same impulse unilaterally, the players group concerned can expect the results produced in Table 5a.3. Qualitatively speaking, the results do not deviate from the ones given in the previous table. The magnitude of the expansion at home, however, is smaller. This is due to the instantaneous switch to foreign products caused by the home price rise. In terms of Diagram 5.2, this is reflected by a smaller shift in the demand curve (arrow 1, and consequently, also arrows 2 and 3). By the same token, this implies an expenditure impulse in the outside countries. So, the latter can expect similar effects as the home country, albeit to a considerably smaller extent. Apart from the magnitude of the effects, the only difference can be found in the government sector: whereas the home country runs a deficit (in period two the extra government purchases are partly compensated for by fewer unemployment benefits and in the subsequent periods also by increased profit tax receipts), the outside world runs a surplus on the government account, due to fewer unemployed in those countries.

A comparison with the complementarity case (see Table 3a.4) indicates that now production rises immediately in the home country (in 3a.4 in period 4) as well as abroad (in Table 3a.4 not until period 6). Whereas the former is an immediate implication of the rising -as opposed to vertical- supply curve, the latter is attributable to the immediate rise in household income in the home country (which in turn is also caused by the rising supply schedule). The same rise in labour income also explains why the trade balance shows an immediate deficit now, whereas in Table 3a.4 the deficit did not emerge before period 4.

As far as the 'economic' variables are concerned, the new long run equilibria in both tables are identical, however. So, also under the present assumption we can conclude that a unilateral demand impulse will partly leak away, benefitting production, employment and final private absorption in the outside countries to a relatively small extent, both in the short and in the long run.

Assumptions: no monetary sector, non-vertical supply curve, world-wide impulse

If the unilateral action was undertaken with (world-wide) flexible exchange rates, however, Table 5a.3' indicates that country one's economic variables would move in virtually the same way as they did when the action was world-wide, while the ones in the outside world would not be affected. Hence, flexible exchange rates would ensure a nearly perfect insulation in this case.

As the table indicates, in the present situation the depreciation is obtained in the impulse period, whereas with complementarity (see Table 3a.5) this depreciation occurs later and is smaller. The depreciation is earlier now as a consequence of the immediate expansion of employment and thus of labour income. It is larger now, since with complementarity employment only grows with capital formation, whereas now it also grows if demand goes up: the short term reaction of employment to a demand impulse is sooner and larger if there are possibilities of substitution between the factors of production.

3. A wage increase

Assumptions: no monetary sector, non-vertical supply curve, world-wide impulse

Table 5a.4 confirms the expectation formulated in Section 2 of this chapter that a world-wide wage increase (here: of 10%) neither changes demand nor supply in real terms. The only impact is a one time increase in output and consumer prices (equal to the wage increase), harming welfare.

Assumptions: no monetary sector, non-vertical supply curve, unilateral impulse, fixed exchange rates

If just one of the countries decided to increase its overall wage level, Table 5a.5 would give an impression of the results to be expected, when the system of fixed exchange rates would be adhered to. In the impulse period, just as in Diagram 5.4, the marginal cost curve goes up by 10% at given output levels. Demand for home products, however, no longer increases -in nominal terms- to the same 10%: as a result of the price increase, our exports fall, depressing demand and consequently the price increase. This leaves room for (net) real wages to go up (as indicated by the increase in w_B), and thus for an increase in home and especially imported consumption.[13] The drop in exports will make home production fall below its starting level. Given the capital stock, employment will shrink even more sharply. This explains why total private consumption (co_1+ m_1) does not rise to the same extent as net real wages do.

Meanwhile, because of the increase in real wages, profits become negative, implying disinvestments in period t = 3. An immediate effect of this will be lower demand for products, and consequently, a further decline in employment. Prices also go down, increasing exports which attenuates the decline in production.

After period t = 3, due to net losses in the past, the capital stock starts declining. This helps restore profits in two ways. On the one hand, employment and thus labour costs fall. On the other hand, with a smaller stock of capital, the supply curve moves to the left, pushing output prices up.

In the end the economy reaches a new equilibrium with lower output and employment and a 10% higher output price level in the home country, and

higher output and employment and on balance unaffected output prices abroad. If the trade balance deficit of the home country is also taken into account (caused by a higher household income and a worsened competitive position), it cannot come as a surprise that welfare in the home country is harmed, whereas it rises abroad.[14]

Assumptions: no monetary sector, non-vertical supply curve, unilateral impulse, flexible exchange rates

The results obtained with fixed exchange rates change drastically if exchange rates float. See Table 5a.6.

Just as with a multilateral wage impulse, the real sector is unaffected here. The deficit on the trade account, as signaled in the previous table, is now replaced by a depreciation equal to the wage impulse, which also equals the production price increase. Consequently, the only effect left is a one time price increase in the home country.

4. Supply-side policy

Assumptions: no monetary sector, non-vertical supply curve, world-wide impulse

If, as in this chapter, investments are determined by net profits, a policy to increase investments via tax rate reduction can only be fruitful if profits are positive in the first place. Therefore, we combine such a (world-wide) tax reduction of 10% points with a (world-wide) government expenditure increase of 10%. Hence, to interpret the effects of the tax rate policy, we should compare the results in Table 5a.7 with the ones in Table 5a.2. These effects are rather straightforward, but nevertheless interesting. Of course, the tax rate reduction will induce more investments in $t = 3$, implying a higher secondary demand impulse in that same period. Consequently, production, employment and prices exceed the levels reached in Table 5a.2. Supply considerations start to play a role in $t = 4$. Since capital formation is larger now, the supply schedule is shifted outward. This facilitates a larger production expansion with prices dropping faster.[15]

This process of a more rapid outward shift of the supply schedule, more production and lower prices is repeated in the periods thereafter.

A noticeable result is that a policy stimulating capital formation this way is also beneficial in a fight against unemployment and inflation[16] in the short run. As signaled in Chapter 3, however, the policy actually boils down to speeding up the adjustment process towards the same long run equilibrium that would have been reached without it.

Section 3A.2 Simulations without a monetary sector and a vertical supply curve

As described in the first section of this chapter, the supply curve contains a vertical branch at the point where labour limits production capacity.

The initial position

To study the general behaviour pattern of the model in this branch, let us first turn to Table 5a.8 where a new equilibrium starting position is created for the impulses in this section. This new equilibrium is established by a reduction in the private production capacity to the level of the initial production (100) through an increase of 3.75[17] in the number of civil servants while compensating for the side effects of this move on demand.[18] What actually happens diagrammatically is that the vertical branch of the supply curve is moved to the left until the initial production point (point A in Diagram 5.2) is reached. As Diagram 5.5 illustrates, the initial production point (still A) is now situated at the kink in the supply curve.

As shown in Table 5a.8, actual production stays at 100. We move into the vertical branch of the supply schedule, indicated by 'model = 0', since, to circumvent problems due to rounding, the computer chooses this value for 'model' on the condition that actual production times 1.0001 exceeds private production capacity (of 100). Neither in the short, nor in the long run, does this move have any impact on the economic variables in the model. Obviously, the impact on 'welfare' is beneficial: it is for once and for all increased to the level of 100.94, due to decreased unemployment.[19]

The picture drawn by Table 5a.8 is our point of reference when analyzing the model's behaviour at full capacity output.

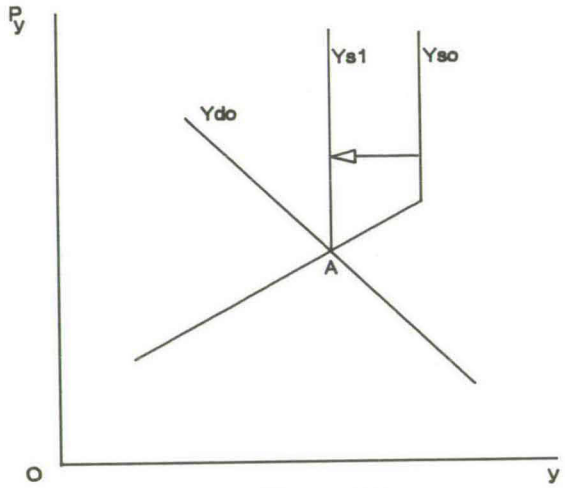

Diagram 5.5

1. Government expenditure increase

Assumptions: no monetary sector, vertical supply curve, world-wide impulse
Let us first study the effects of a (world-wide) increase in government purchases[20] given in Table 5a.9 and illustrated in Diagram 5.6.
The impulse as such is reflected by the move from A to B in this diagram: the extra demand by the government crowds out private consumer expenditure via a price increase (see column 2 in the table). Higher output prices lead to higher profits, producing extra demand for investment purposes in the next period, t = 3. This extra demand (reflected by arrow 2) provides a further impetus to prices and profits. In the subsequent period (t=4), the increased stock of capital, at given employment, implies a higher production capacity, moving the vertical supply curve to the right (arrow 4). As such, this pushes prices down. However, due to the high profits in t = 3 and the consequently high investments in t = 4, the demand increase exceeds the output increase, increasing prices and profits further.

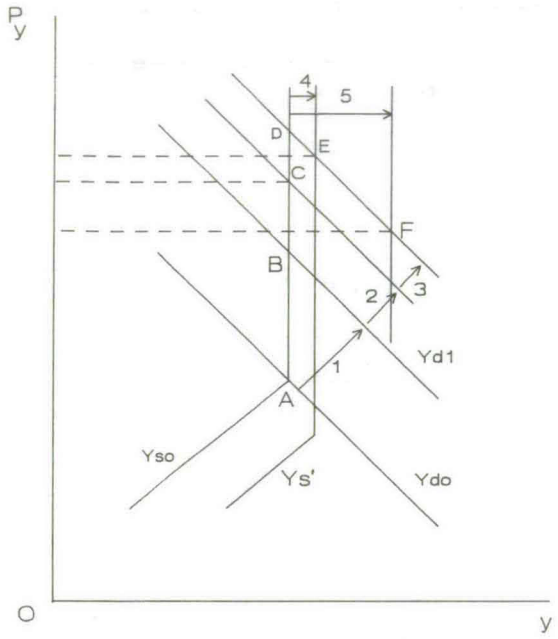

Diagram 5.6

Diagram 5.6 also contains the outward shift of the supply curve in the event employment rises proportionately to the rise in the capital stock (arrow 5). The latter applied in Table 3a.2, an expenditure increase assuming complementarity between the factors of production with capital as the bottleneck for production.[21] There, $\dot{y} = \dot{\ell} = \dot{k}$, whereas in the current set of assumptions, $\dot{\ell}_m = 0$ and $\dot{y} = (1-\beta)\dot{k} < \dot{k}$. So, compared to the complementarity case, the fact that output prices in t = 4 (E) are larger than those in t = 3 (C) can be attributed to the stickiness of labour supply: if labour had been abundant, prices would have fallen (to F).

This procedure of higher output prices and higher profits and investment is repeated in all reported periods. Since nominal net household income is constant by definition, the ever increasing price level leads to a crowding out of private consumption by investments. As stated in Section 2, one way of stabilizing this process would be to change the investment equation. To illustrate this point, Table 5a.9' is included, where beyond t = 3 investments are kept constant in real terms. The table confirms the

outcome of Appendix 5.2: the increase in capital in period 4 cet. par. causes output prices to fall and profits to erode. With fixed investments, the capital stock reaches its new long term value in period 8 and with it the complete economy becomes stationary. Once more, for reasons of comparability, we stick to the investment equation used in Chapter 3.

The process of long run destabilization was found in all situations where the 'supply model' applied. Only if the economy returned to "model = 1" did the process became stable again.
We will illustrate these two statements with the help of a few other impulses.

2. Decrease in the labour tax rate

Assumptions: no monetary sector, vertical supply curve, world-wide impulse
Firstly, a demand shock not found in public but in private consumption is described in Table 5a.10. In that table the tax rate on household (labour) income is decreased by 3 per cent leaving room for a demand increase. In the impulse period the variable model still equals one: the extra production is not high enough to result in a zero unemployment rate. But due to the higher profits, extra demand for investment purposes in the subsequent period makes 'model' switch to zero. From then onwards, the process described above -of expanding capital stock, increasing profits and increasing prices- is obtained.

3. Hiring extra civil servants

Assumptions: no monetary sector, vertical supply curve, world-wide impulse
Second, what happens if, starting in point A in Diagram 5.5 again, the government decides to hire more extra labour, thereby restricting private production capacity to below the initial 100? Again we manipulate civil servants' salaries and government purchases to free the impulse from 'automatic demand-elements'.[22] The results are listed in Table 5a.11. Diagrammatically, the main effects can be reproduced in the form of Diagram 5.7.

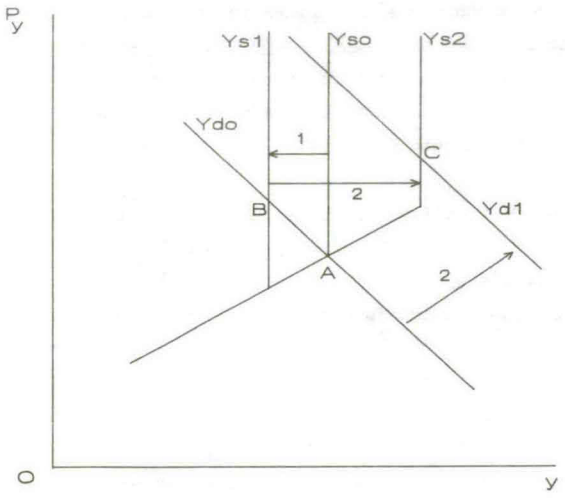

Diagram 5.7

In t = 2, the reduction in private employment (arrow 1) causes production to go down: from point A to point B. The downward slope of the demand curve makes prices go up, thereby increasing realized profitability. Consequently, in the next period demand for investment purposes increases, constituting a further impetus to prices and profits. Again, the price reducing effect of capital accumulation is outweighed by the price increasing effect of extra investment demand. After a temporary reduction, both private production capacity and prices exceed the levels they had without the hiring of extra civil servants. See arrows 2 in Diagram 5.7.

4. A temporary decrease in the labour tax rate

Assumptions: no monetary sector, vertical supply curve, world-wide impulse
Now let us turn to a table dealing with an impulse that initially switches the model into the supply branch and afterwards switches it back again into the demand branch, to check if, as claimed, the tendency towards a new equilibrium is restored.

In Table 5a.12 a temporary reduction of 3% in the labour tax rate is reported in periods 2 up to 5, i.e., in period 6 the initial tariff of 24% is reestablished. See bottom line of this table.
Periods 1 to 5 are identical to those in Table 5a.10 discussed above, where in period 3 'model' gets the value zero. When in period 6 the initial tax rate is restored, consumer demand falls back, pushing output prices down and unemployment up. 'Model' equals one again and losses are incurred. As an inheritance from the past, in periods 6 up to 9, the capital stock still grows.[23] Output prices therefore drop further and losses increase. But in period 10, when the stock of capital, due to the losses mentioned, starts declining, prices are forced back up again and losses are smaller. A comparison between periods 2 and 1000 indicates that the model is stable again. In fact, the 'new' equilibrium equals the starting position, illustrating that temporary shocks are, as usual, absorbed.

In Section 2 of this chapter, we expressed the expectation that starting in point A of Diagram 5.5 an overall wage impulse, except for a one time price increase, would not influence the real sector in the economy. Moreover, if only wages in the private sector were to be enhanced, starting in that same point A, we expected a new long run equilibrium since 'model' would switch back to one. We will now verify these points.

5. Wage policy

Assumptions: no monetary sector, vertical supply curve, world-wide impulse
In Table 5a.13 all wages (including those in the public sector) are increased by 10%. As expected, only the wage and price level are increased. Nothing else happens.
In Table 5a.14, at the same time as the impulses are given to obtain point A of Diagram 5.5, only wages in the market sector are increased by 10%.[24] Starting in A (Diagram 5.5), the marginal cost curve responding to the rise in wage costs rises by 10%. Nominal demand, however, does not meet that rise: total civil servants' income was kept constant and the unemployed were assumed to keep their original payments -in nominal terms-, so the demand curve rises by less. As a consequence, the variable 'model' in period two gets the value 1. The rise in output prices is less than the

10% increase in wages, which leads to negative profits. At the same time, since output is pushed back, with a constant capital stock, this holds a forteriori for private employment, further curtailing consumer demand.
Next period's disinvestments lower production, employment and consumption further. Prices and (negative) profits are also diminished.
In period 4 disinvestments shrink the available stock of capital, raising output prices and mitigating losses. This pattern is repeated in the subsequent periods.
A new long run equilibrium is found once output prices have gone up as much as private wages have, which can only be established at a lower output- and employment-volume. Total (real) household consumption is in all periods smaller than without the wage rise. In the beginning this is due to price increases, harming consumption by civil servants. Later on this is established by the invoked unemployment when compared to starting point A in Diagram 5.5.

Section 3.B Simulations if the model contains a monetary sector

This section can be very brief. Analogous to Chapter 3, we will only illustrate that the combination of the present investment function with the monetary sector given in Chapter 2 may result to didactically undesirable and sometimes even perverse results.
Table 5b.1 shows that a contractionary monetary policy in the initial situation of no profits or losses does not change Y_R. Hence, monetary policy in this case does not have any impact on the real sector.
But a more fundamental reason for rejecting a possible combination of a monetary sector with the real sector described above can be deduced from Tables 5b.2 and 5b.3. In the latter, results of a contractionary budgetary policy are shown. One of the effects is the emergence of losses invoking net disinvestments.
One would expect that these disinvestments would be larger if a contractionary monetary policy is added. Table 5b.2 shows a opposite effect: from period five onwards investments under a contractionary monetary regime are larger.

The explanation of these 'strange' effects was given in the final section of Chapter 3.

Like in Chapter 3 we conclude that combining the present real sector with the monetary block would didactically be undesirable.

Appendix 5.1. The impact of a larger capital stock on employment, output prices and profits, if the supply curve slopes upward

Under the assumptions that nominal wage rates are fixed and that total net household income (say D) is spent, the production block is likely to imply a positive impact of a larger capital stock on employment. This point is proven as follows.

The demand curve,[25] is rewritten as:

$$P_y = D.y^{-1} \tag{1}$$

where $D = (1-\bar{T}_L)(\ell\bar{P}_L+\bar{\ell}_g\bar{P}_{LCS}+\ell_u\bar{P}_{Lu})$ [26]

so, $dD = (1-\bar{T}_L)(\bar{P}_L d\ell+\bar{P}_{Lu}d\ell_u)$

and, since $d\ell_m = -d\ell_u$,

$$dD = (1-\bar{T}_L)(\bar{P}_L-\bar{P}_{Lu})d\ell \tag{2}$$

The supply curve, (5.4) is rewritten as

$$P_y = \frac{\bar{P}_L}{\beta}\left(\frac{y}{k}\right)^{\frac{1-\beta}{\beta}} \tag{3}$$

where $y = \ell^{\beta}k^{1-\beta}$

so, $dP_y = \frac{\bar{P}_L}{\beta} d(\ell^{1-\beta}k^{\beta-1})$

hence, $dP_y = \frac{\bar{P}_L}{\beta}((1-\beta)k^{\beta-1}\ell^{-\beta}d\ell+(\beta-1)\ell^{1-\beta}k^{\beta-2}dk)$ (3)'

(1) leads to

$$dP_y = -Dy^{-2}dy + y^{-1}dD \tag{1}'$$

If in (1)' equation (2) is substituted together with

$$dy = \beta k^{1-\beta} \ell^{\beta-1} d\ell + (1-\beta) \ell^{\beta} k^{-\beta} dk \qquad (1)''$$

which follows from the production function, equalling (1)' and (3)' results in

$$-\frac{D}{y^2}(\beta k^{1-\beta}\ell^{\beta}\ell^{-1}d\ell + (1-\beta)\ell^{\beta}k^{-\beta}dk) + \frac{1}{y}(1-\bar{T}_L)(\bar{P}_L - \bar{P}_{Lu})d\ell$$

$$= \frac{P_L}{\beta}((1-\beta)k^{\beta-1}\ell^{-\beta}d\ell + (\beta-1)\ell^{1-\beta}k^{\beta-2}dk) \qquad (4)$$

If in (4) account is taken of $\ell^{\beta}k^{1-\beta} = y$ or $\ell^{\beta}k^{-\beta} = yk^{-1}$

or $k^{\beta-1}\ell^{-\beta} = y^{-1}$ or $\ell^{1-\beta}k^{\beta-2} = \frac{\ell}{k}y^{-1}$ (4)'

and if both sides are multiplied by $\frac{k}{\ell}\frac{y}{1-\beta}$, the following expression for $\frac{\dot{\ell}}{\dot{k}}$ $(= \frac{d\ell}{dk}\frac{k}{\ell})$ is found:

$$\frac{\dot{\ell}}{\dot{k}} = \frac{\frac{\bar{P}_L}{\beta} - \frac{D}{\ell}}{\frac{D}{\ell}\frac{\beta}{1-\beta} + \frac{\bar{P}_L}{\beta} - \frac{(1-\bar{T}_L)}{(1-\beta)}(\bar{P}_L - \bar{P}_{Lu})} \qquad (5)$$

where in terms of the main text, $D = (1-\bar{T}_L)(Y_L+TRF)$ and $\ell = \ell_m$.
Exceptional cases left aside, both numerator and denominator are positive in the game.[27] As a result, in general an increase in the capital stock causes an increase in employment.
The final term in the denominator refers to the impact on employment of the job creation itself: if unemployed are paid less than the private wage rate, i.e., $P_L > P_{Lu}$, their extra expenditures once they are employed shift the demand curve to the right, which enhances the job creating effect of the capital stock enlargement. In equation (5), this effect causes the denominator to fall, and as a result $\dot{\ell}/\dot{k}$ to rise.

If (5) (rewritten as $\frac{d\ell}{dk}$) is substituted into (3)', we get

$$dP_y = \left[\frac{P_L}{\beta}(1-\beta)k^{\beta-1}\ell^{-\beta}\left[(\frac{P_L}{\beta}\frac{\ell}{k} - \frac{D}{k})/(\frac{D}{\ell}\frac{\beta}{1-\beta} + \frac{P_L}{\beta} - \frac{(1-\bar{T}_L)}{(1-\beta)}(\bar{P}_L-\bar{P}_{Lu}))\right]\right.$$

$$\left. + \frac{P_L}{\beta}(\beta-1)\ell^{1-\beta}k^{\beta-2}\right]dk \qquad (6)$$

where $k^{\beta-1}\ell^{-\beta} = y^{-1}$ and $\ell^{1-\beta}k^{\beta-2} = \frac{\ell}{k}y^{-1}$ (see above), hence, if the term in [ ] in (6) is summarized as [...]

$$dP_y = \frac{P_L}{\beta}\frac{(1-\beta)}{y}([\ldots] - \frac{\ell}{k})dk$$

which is negative if $[\ldots] < \frac{\ell}{k}$ (7)

that is: $\frac{dP_y}{dk} < 0$ if[28]

$$\frac{P_L}{\beta} - \frac{D}{\ell} < \frac{D}{\ell}\frac{\beta}{1-\beta} + \frac{P_L}{\beta} - \frac{1-\bar{T}_L}{1-\beta}(\bar{P}_L-\bar{P}_{Lu})$$

or $$\frac{D}{\ell_m} > (1-\bar{T}_L)(P_L-P_{Lu}) \qquad (8)$$

which condition always holds since $D = (1-T_L)(\ell_m P_L+\ell_g P_{LCS}+\ell_u P_{Lu})$.

In other words, an expansion of the capital stock always leads to falling output prices and cet. par. to an erosion of profits thereby mitigating the incentive for a further expansion of the capital stock and paving the way for the model to reach new stationary equilibrium.
More formally, the change in profits as a consequence of the increase in the capital stock is calculated as

$$\frac{dY_R}{dk} = \frac{dY}{dk} - \frac{dY_L}{dk} - \frac{d(\delta P_y k)}{dk} = P_y\frac{dy}{dk} + (y-\delta k)\frac{dP_y}{dk} - P_L\frac{d\ell}{dk} - \delta.P_y \qquad (9)$$

In (9), the first term on the right hand side follows from (1)'', the second from (3)' and the third from (5). If account is taken of (4)', this

leads to

$$\frac{dY_R}{dk} = P_y\beta \frac{y}{\ell} \frac{d\ell}{dk} + P_y(1-\beta) \frac{y}{k} + \frac{y-\delta.k}{y} \frac{P_L}{\beta} (1-\beta) \frac{d\ell}{dk} +$$

$$+ \frac{y-\delta k}{y} \frac{P_L}{\beta} (\beta-1) \frac{\ell}{k} - P_L \frac{d\ell}{dk} - \delta.P_y$$

or, after multiplying by $\frac{k}{\ell}$,

$$(\frac{k}{\ell}) \frac{dY_R}{dk} = (P_y\beta \frac{y}{\ell} + \frac{y-\delta.k}{y} (1-\beta) \frac{P_L}{\beta} - P_L) \frac{\dot{\ell}}{\dot{k}} +$$

$$P_y(1-\beta) \frac{y}{\ell} - \frac{y-\delta k}{y} \frac{P_L}{\beta} (1-\beta) - \frac{\delta.P_y k}{\ell} \qquad (10)$$

In (10) $\frac{\dot{\ell}}{\dot{k}} < 1$ (see Appendix 5.1, equation 5).

As a consequence, $dY_R/dk < 0$, as long as β is in the neighbourhood of the share of the wage bill in total sales,[29] and as long as $y \approx \ell \approx k$. Both conditions hold in the initial equilibrium, for example.

Appendix 5.2. The impact of a larger capital stock on output prices and profits, if the supply curve is vertical

In the "supply-branch", per definition $d\ell_m = 0$. With given wages, this implies that dY_L, as well as $d((1-\bar{T}_L)(Y_L+TRF))$ are zero.

Moreover, it implies that ℓ_m in the supply curve is replaced by $\bar{\ell}_m$.

So, the demand curve reads as

(1) $P_y = \bar{D}y^{-1}$ [30], where $D = (1-\bar{T}_L)(\bar{Y}_L+\overline{TRF})$

The supply curve reads as

(2) $y = \bar{\ell}_m^{\beta} k^{1-\beta}$

From (1): $dP_y = -\bar{D}y^{-2}dy$

where dy, following (2), can be replaced by

$$(2) \rightarrow dy = y.(1-\beta)k^{-1}dk$$

hence,

$$\frac{dP_y}{dk} = -\frac{\bar{D}}{y}(1-\beta)k^{-1} < 0 \qquad (3)$$

or $$\frac{\dot{P}_y}{\dot{k}} = -(1-\beta) < 0 \qquad (4)$$

The impact on profits follows from

$$\frac{dY_R}{dk} = \frac{d(Y - Y_L - \delta k P_y)}{dk} = \frac{dY}{dk} - \frac{d(\delta k P_y)}{dk} \qquad (5)$$

In (5), with a price elasticity of one, dY = 0, in line with (1).[31]

Hence,

$$\frac{dY_R}{dk} = -\delta(P_y + k\frac{dP_y}{dk}) = -\delta(P_y - \frac{\bar{D}}{y}(1-\beta)) < 0$$

NOTES (Chapter 5)

1 If capital was the bottleneck for production.

2 Since β_0 is constant and set at 1, we will leave out β_0 in the description here. Nevertheless, the game leader is allowed to change β_0.

3 R.C. Marston, 'Real and Monetary Disturbances in an Exchange Rate Union', NBER Working Paper Series, nr. 705, June 1981. The marginal cost curve described by (5.4)' is upward sloping and therefore always situated above the average (variable) cost curve. Consequently, it can for the full extent be regarded as the supply curve.
With β at 0.8 (so larger than 0.5) P_y is a degressively increasing function of y. This is in compliance with a positive value of the third derivative of y with regard to l_m in (5.1). For convenience the supply curve is drawn as a straight line.

4 From now on, we will talk of the supply curve as situated in a diagram with P_y on the vertical axis and y on the horizontal, both in absolute as opposed to relative terms.

5 The computer is assigned to take as the solution the maximum of $\frac{Y}{y_{max}}$ and $\frac{Y}{y_s}$ since a demand curve always intersects both with $\frac{Y}{y_{max}}$ and with $\frac{Y}{y_s}$, where only one point of intersection is relevant. See Chapter 3.

6 As stated in Chapter 2 (see eq. 2.14), the game leader has a choice between an immediate and a lagged impact of productivity. The simultaneity of the solution process is strongly enhanced if he chooses an immediate impact here: demand is determined by wages; demand and supply determine volumes, and thereby labour productivity, which determines wages again. Moreover, wages are a shift parameter in the supply curve. As a consequence, it would be advisable to choose a lagged impact here, also since reduction of this simultaneity has a didactical advantage. Finally, it would resemble (Dutch) practice at this point: wages are negotiated on the basis of past labour productivity growth. The reader is reminded, that throughout Chapters 3 to 6 nominal wages are assumed constant, unless otherwise indicated.

7 In Diagram 5.2, just like in previous chapters, for convenience the demand curve is drawn as a linear negatively sloped curve. In fact, it is not linear since its main component, consumer demand, is structured as $c = Y_L.P_y^{-1}$. The supply curve is also not linear as can be read from equation (5.4).

8 The fall in consumption would again be larger if wages were a function of (decreased) labour productivity in comparison to the situation without productivity determined wages as discussed in the text.

9 In that appendix it is assumed that all countries act simultaneously. If only country one would act, for example, the fall in its prices caused by its higher capital stock, could lead to higher exports so a

further outward shift of the demand curve. As illustrated by the simulations below, this does not lead to stability problems in the present game.

10 This is more easily seen if (5.4)' is rewritten as:

$$\dot{P}_y = \frac{1-\beta}{\beta}\dot{y}_s + \dot{P}_L \qquad (5.4)''$$

11 Remember that salaries of civil servants as well as unemployment benefits are linked to the wage in the private sector.

12 This problem was not serious enough, however, to block the computer in calculating the results of any of the submitted impulses all of which were 1000 periods long.
One way to prevent destabilization is to replace the autonomous component in the investment equation (δk) by a fixed number (20). If so, investments do not rise since the stock of capital is high, that is, since investments used to be high. This way one reduces the outward shift of the demand curve. An alternative way, illustrated below, would be to directly fix real investments. Since changing the assumed investment behaviour would reduce comparability with the other chapters, we stick to the original investment equation.

13 The latter constitutes a demand increase abroad, giving rise to effects as described in Table 5a.3 above. Note that a (nominal) household income increase of 10%, as described here, has a far greater impact on demand than a 10% increase in government purchases. (Initially net household income equals 76, whereas the latter equals 4.) This explains why even the effects leaked away here can still have the large impact described in the current table: these effects perceived abroad are larger than those in Table 5a.2, e.g. Again, in the game players are not allowed to increase wages by such a high amount as 10%.

14 As stated, the effects on the outside world are, qualitatively speaking, to a large extent similar to the ones that will be perceived by a country unilaterally increasing its government expenditures. See Table 5a.3.

15 To illustrate the respective price movements (seemingly identical in the short run due to rounding), the variable 'INF' is included in the table, indicating the relative price movements. INF(G) refers to those with only an expenditure increase.

16 Albeit that the latter is enhanced in the short run, due to extra demand for investment purposes.

17 That is an increase of ℓ_g by 3.75/22 = 17.04545%.

18 First, since civil servants are paid more than the unemployed, total transfer payments would go up, increasing private consumer demand. To compensate, the new salary for those servants is lowered, to keep transfers at 20. That is: since $\ell_g \times P_{LCS} = 20$ while ℓ_g is 25.75 now, P_{LCS} becomes 20/25.75 = 0.7767 (rounded) instead of 0.8, or a decrease in government salaries of 2,9126% (rounded).

Second, 3.75 extra civil servants means an automatic increase in material government expenditures of 0.1 × 3.75 = 0.375. To keep public spending at its former level, g is reduced by 0.375/4 = 9.375%.

19 Welfare stays at its new level since the beneficial effects of zero unemployment ($\Delta W = +0.25$), zero inflation ($\Delta W = +0.25$) and a balanced government account ($\Delta W = +0.25$) is exactly outweighed by the unbeneficial effect of a balance of payments unequal to +4 ($\Delta W = -0.75$). In Table 5a.1, the initial situation in the game, welfare drops by 0.25 a year.

20 Technically, this is done by leaving out the 9.375% decrease in g included in Table 5a.8.

21 If the relative magnitudes of the respective impulses are taken into account, price and investment developments in periods 2 and 3 are identical in Tables 3a.2 and 5a.9.

22 The respective impulses here are: $\Delta \dot{\ell}_g = 5$ (so $\dot{\ell}_g = 22.7272\%$ rounded), $P_{LCS} = -7.4074\%$ rounded and $\dot{g} = -12.5\%$.

23 In those periods as a consequence of the violation of the cet. par. clause, the positive relation between capital stock and employment as found in Appendix 5.1 is blurred.

24 The impulses given here are calculated as follows. Since $\Delta TRF = 0$ with initially $\dot{\ell}_u = 0$, $\dot{\ell}_g$. $P_{LCS} = 20$, where $\dot{\ell}_g = 25.75$. Since $P_{LCS} = ((1+\dot{P}_L)P_{LCS_{-1}})(1+\overline{\dot{P}_{LCS}})$, with $\dot{P}_L = 0.1$, this implies $25.75 \times 0.88 \times (1+\overline{\dot{P}_{LCS}}) = 20$, so $\dot{P}_{LCS} = -11.739$ (rounded).

25 We concentrate on private consumer demand here, as real government expenditures were assumed to be exogenous. We refrain here from possibly changing investments.

26 For convenience we write $\dot{\ell}_m$ as $\dot{\ell}_m$ or as $\dot{\ell}$ in this appendix.

27 Moreover, $\frac{\dot{\ell}}{\dot{k}} < 1$ as will be shown below (conditions (7) and (8)).

28 We assume here that the denominator of (5) is indeed positive.

29 If so, $\beta P_y = P_L$ and $(1-\beta)P_y = \delta P_y$.

30 See Appendix 5.1: given $g = \bar{g}$ and $i = \bar{i}$.

31 If the other spending categories, investments and government purchases, are constant in nominal terms.

Chapter 6 Substitutable factors of production, investments determined by the 'optimal' stock of capital

Chapter 6 contains:

Section 1. Introduction: the investment block

Section 2. The global patterns of adjustment / some simulations

Section 1. Introduction: the investment block

Apart from the section on investments, the model used in the current chapter is identical to the one presented in Chapter 5. The starting point for determination of the investment volume is the one traditionally used if possibilities of substitution between factors of production are assumed. Examples are found in Kopcke, Jorgenson, Claassen and Scotland.[1] All start from the same proposition: investments, partly or completely, close the gap between the actual and the 'optimal' stock of capital, where 'optimal' is defined as the stock minimizing production costs.

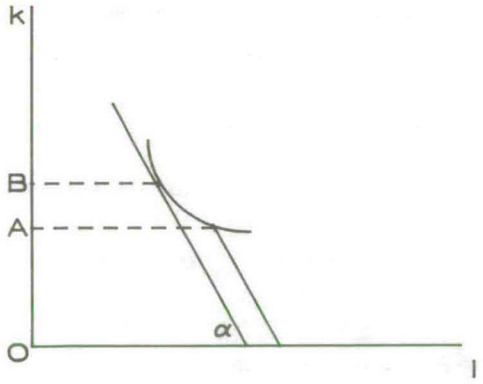

Diagram 6.1

This procedure can be illustrated by use of Diagram 6.1. In that diagram an isoquant is drawn that can be derived from the production function. Minimization of production costs is found at a capital stock OB given the

ratio of the (expected) price of labour over the (expected) price of capital equal to tg α. If the actual capital stock is resembled by OA, investments equal (a part of) the resulting gap AB.

How should the optimal capital stock be determined? Obviously it does not only depend on relative factor prices, but also on output.
A problem is raised here by Borch when discussing Jorgenson's 1963 contribution (same reference) with regard to the determination of the optimal capital stock. He states (p.273) that it is correct to determine output and employment for a given stock of capital on the short run, but that it would be suboptimal to subsequently let actual output determine the desired capital stock. This point is developed further by Gould and Waud[2] who state that "The use of actual output to determine the optimal capital stock is appropriate only in comparative static equilibrium situations or when capital can be acquired without adjustment costs or other constraints" (p.34) "One way around these problems is to derive a target or desired capital stock which depends only on exogenous quantities that are unaffected by the firm's decisions or adjustment process"(p.35). On the basis of a demand function and the production function, they develop an equation for the desired capital stock depending on factors exogenous to the investor. But they argue (footnote 9, p.36) that this "equation ... is strictly correct in a dynamic context only when the exogenous variables are expected to remain constant for some (presumably fairly long) period of time. The investment process then represents an adjustment to the long-run (stationary) equilibrium ... If this is not the case (i.e., if the exogenous variables are expected to change substantially over time), then a much more complicated model...(for the)... definition of the desired capital stock...is need(ed)". In other words, as in the SIER Game such a stationary situation in the "exogenous" variables is not obtained, their equation is not suitable for our model. Another (set of) equation(s) is needed, satisfying the same requirement formulated by Gould and Waud, that only factors exogenous to the investment decision should determine the desired stock of capital. As present investment decisions do not lead to changes in the capital stock earlier than two periods later, in the SIER Game expected output and expected product and factor prices (beside other items) determine the desired stock of capital.

We will first turn to this starting point (determination of k^* and with it of the gap). Subsequently, we will discuss two kinds of investment behaviour, one following the traditional path described above, and one alternative investment function based on optimizing rather than maximizing behaviour.

Determination of the 'gap'

The cost minimizing stock of capital, k^*, is found where the ratio of the expected price of capital to that of labour equals the ratio of their respective marginal productivities[3]:

$$\left[\frac{\delta y}{\delta k}\right]^e / \left[\frac{\delta y}{\delta \ell}\right]^e = \left[\frac{P_k}{P_L}\right]^e$$

Or, since the production function implies as partial derivatives

$$\left[\frac{\delta y}{\delta k}\right]^e = \left[\frac{y}{k}\right]^e (1-\beta) \text{ and } \left[\frac{\delta y}{\delta \ell}\right]^e = \left[\frac{y}{\ell}\right]^e \beta ,$$

the production cost minimizing technique (*) is found where

$$\left[\frac{\ell}{k}\right]^* = \left[\frac{P_k}{P_L}\right]^e \frac{\beta}{1-\beta} .$$

Combined with the expected output level y^e (discussed below) and with the production function, this leads to

$$k^* = y^e / \left[\left(\frac{\beta}{1-\beta} \left[\frac{P_k}{P_L}\right]^e\right)^\beta \right] \qquad (6.1)^4$$

In (6.1), expected output, y^e, is calculated as the minimum of expected production capacity on the one hand (if labour is expected to be short), and expected production with unlimited labour supply, on the other. The latter is determined by expectations for two years ahead with regard to output prices (P_y^e), labour costs (P_L^e), and the capital stock.

The expected macro-economic capital stock, k^e, equals the present one minus the machines that will have become obsolete plus this period's investments (i) and next year's investments (i_{t+1}). The latter component equals the presently planned investments (i_D). At this point it should be remembered, however, that the expected capital stock is needed to determine expected output in order to get this period's investment decision. This would imply the circle that Gould and Waud criticized (investment plans determine themselves). As in Chapter 4, to break this circle we postulate that macro-economic investments expected for next year(i.e., this period's investment decisions) equal actual (current) investments corrected for the growth in real final demand.

Once "expected output with ample labour supply" (y_s^e) is known, it is compared with the expected production capacity, cap^e, determined by expected labour supply (ℓ_s^e), expected government demand for labour (ℓ_g^e) and expected capital stock (k^e).

The minimum of y_s^e and cap^e equals expected real output, y^e.

Finally, expected nominal demand (Y^e) over y^e equals expected output prices, P_y^e.

Formally:

if

FA' = weighted rate of growth in (c+g+x) during periods t - ϑ,...,t and

e(superscript) = expected value in period t + 2

then

$$k^e = k - i_{t-\vartheta} - i_{t-\vartheta+1} + i_t + i^e_{t+1} \tag{6.2}$$

(where $i^e_{t+1} = FA' \times i$) (6.3)

$$y_s^e = k^e(\beta \times P_y^e/P_L^e)\ \frac{\beta}{1-\beta} \tag{6.4}$$

$$cap^e = (\ell_s^e - \ell_g^e)^{\beta} \times (k^e)^{1-\beta} \tag{6.5}$$

$$P_y^e = \frac{Y^e}{y^e} \tag{6.6}$$

where y^e is the minimum of y_s^e and cap^e (6.7)

Given expected prices of factors of production[5], the set (6.1) - (6.7) suffices to calculate k^*. The 'gap' equals the difference between k^* and the stock of capital that would result if no net investments were planned (k^e_{t+1}). That is, gap = $k^* - (k - i_{t-\theta} + i_t)$.[6]

Determination of planned investments

Traditionally, one of the following two investment behaviours is assumed:
- either investments equal the complete gap AB (in Diagram 6.1). In that case, apart from a possible decision and installation lag, k is continuously at its 'optimum', and, most elegantly, the macro-economic production function as described in Chapter 5 reflects, through its coefficients, the constant distribution of income;
- or investments are an exogenous fraction of AB[7], gradually shifting the actual capital stock to its 'optimal' size. Now, only in the longer run, that is, as soon as k equals OB (ceteris paribus), is the previous distribution of income restored.

Several objections can be raised against these two alternatives. Entrepreneurs are neither certain of relative factor prices nor of expected sales. If they were for 100% certain of both expected prices and output, OB would indeed result in cost minimization (assuming adjustment costs are absent) and, given sales, in profit maximization. If so, apart from possible technical barriers (see Jorgenson), the second alternative would not make much sense: why should the gap AB only partly be filled if expectations are no less than 100% certain predictions?

The first alternative does not seem too realistic, either. As we will see below, the cost minimizing capital stock can vary sharply over time. Immediate and full adaptations of the investment volume to the resulting 'gaps' would result in drastic empirically implausible changes in investments.

Since the major purpose of the game is first of all to illustrate and explain standard macro-economic theories and concepts, the second alternative is nevertheless included in the game as an option for the game

leader. For the same reason, the simulations to be discussed in this chapter assume this investment behaviour. We prefer, however, the other option available in the game for the game leader, stressing the role of uncertainty in the (dis)investment decision. As this latter option can be regarded as an extension of standard economic theory, it will be illustrated in Chapter 7. Its underlying theoretical considerations will be developed in the remainder of this section.

An alternative investment function

The development of this alternative investment behaviour can be pursued in at least two ways. The first way would be to assume that investments are undertaken up to the point where expected net marginal profitability of investments equals a required exogenous minimum (rho).
This procedure would be facilitated by the convex nature of the isoquant: moving from A in the direction of B in Diagram 6.1 results in a gradually decreasing expected reduction of costs.[8] In other words, given sales, the marginal profitability of investments declines and entrepreneurs invest up to the point where that profitability (net cost reduction as a ratio of investment costs) becomes smaller than rho.
If we were to choose this solution, two problems would arise, namely,

a. how big is the minimum required marginal net rate of return (rho)?[9] And, related to this:
b. as stated above, the cost minimizing capital stock can vary substantially over time, producing widely fluctuating 'gaps'. To allow for some investments, even if this gap is relatively small, rho should not be too modest. This same (exogenous) rho, however, would facilitate vast investments as soon as the gap becomes large. This has as a concrete drawback that in a model like ours where one product per country is manufactured, investments would tend to play a major role in the economy as a demand factor, which conflicts with global empirical observations.

As an alternative, stressing the uncertain nature of expectations, we can choose to endogeneize rho by using an amended version of the so-called "non-Euclidic profit theory" as found in Hartog.[10] In this theory the

optimal size of the firm (i.e., the optimal capital stock) is established via a utility-approach. Utility is here assumed to be an increasing function of expected profits and (given risk aversion) a decreasing function of the amount of capital involved.[11] In this framework, an entrepreneur only strives for maximization of expected profits if uncertainty does not exist or is not one of the determinants of his utility level. In more normal circumstances, however, he optimizes as opposed to maximizes expected profits.

Amended for our problem, we assume that entrepreneurs are "conservative" in the sense that deviation of the capital stock from its present level yields disutility. This disutility grows more than proportionately with the deviation concerned. The disutility could also be based on the existence of financial or social adjustment costs progressively connected to changes in k.

On the other hand, utility grows with expected profits but less than proportionately.

In concrete terms, we assume the following utility-function:

$$U = C_1 \times (Y_R^e + C_2)^{0.8} - C_3 \times (|dk|)^4 \qquad (6.8)$$

where Y_R^e represents the level of expected profits associated with a certain level of the capital stock, and C_1, C_2 and C_3 are constants.[12]

(6.8) has as properties: $\frac{\delta U}{\delta Y_R^e} > 0$, $\frac{\delta U^2}{\delta^2 Y_R^e} < 0$, $\frac{\delta U}{\delta |dk|} < 0$ and $\frac{\delta U^2}{\delta^2 |dk|} < 0$

In other words, extra (expected) profits are valued positive, but a second increase in these profits increases utility less than proportionally; a deviation from the actual capital stock is valued negative, and a second (further) deviation deminishes utility more than proportionally.

Combined with the decreasing marginal productivity feature embodied in the Cobb-Douglas production function referred to above, the hypothesis can be summarized as in Diagram 6.2.

In this diagram, the curve 'd(U) = 0' resembles combinations of net (dis)-investments and expected profits that yield the same level of utility. OC indicates the estimated 'gap' (in absolute terms) between actual and cost

minimizing capital stock. If investments fully close this gap (implying |dk| = OC), the expected increase in profits equals DC. Investment hypotheses based on profit maximization would therefore lead to OC as net investments.

Since in our framework, however, the investor dislikes deviations from the actual number of machines (0), he calculates the increase in his utility level for every marginal increase in investments.[13] Once his utility falls, the process halts and total net investments are known (here OE). In other words, net investments are determined by the point where the increase in utility (by virtue of higher expected profits) is outweighed by the decrease in utility (due to higher net (dis)investments).

If the extra utility caused by the increase in expected profits is lower than the disutility of one unit of investment (i.e., 0.005 × gap, see below), the gap will, ceteris paribus, never be closed and the initial distribution of income will not necessarily be restored.[14]

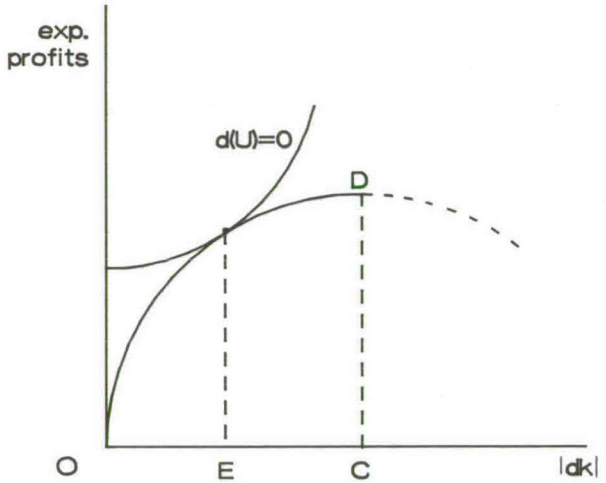

Diagram 6.2

The starting level of utility as indicated by (6.8) is now calculated on the basis of actual net profits and with initially |dk| equal to zero. For each marginal unit of investment, say a_i[15], the expected reduction in

production costs is calculated as the expected reduction in labour costs minus the expected increase in capital costs (both in net terms).
The first part, expected reduction in labour costs, follows from the production function in combination with y^e (determined by 6.7): for each stock of capital the need for labour (i.e., number of workers) equals:

$$\ell_m = \left[\frac{y^e}{\beta_0}\right]^{1/\beta} \quad k^{(1-\frac{1}{\beta})}$$

That is, for each "step" i (extra marginal investment) the expected reduction in labour costs equals (with i = 1...200 and $a_0 = 0$)

$$P_L^e \times \left[\left[\frac{y^e}{\beta_0}\right]^{1/\beta} \left[\underbrace{\left[k^e_{t+1} + \sum_{b=0}^{i-1} a_b\right]^{(1-1/\beta)}}_{(A)} - \underbrace{\left[k^e_{t+1} + \sum_{b=1}^{i} a_b\right]^{(1-1/\beta)}}_{(B)}\right]\right] \qquad (6.9)^{16}$$

For example, if i=49, the factor above (A) in brackets equals k^e_{t+1} + 0.48 gap, and the one above (B) equals k^e_{t+1} + 0.49 gap. As the latter capital stock exceeds the former, required labour is less and the outcome of (6.9) is positive.

The second part, the increase in expected costs of capital, equals

$$P_k^e \times \sum_{b=0}^{i} a_b \qquad (6.10)$$

Total expected reduction in production costs equals

$$(6.9) - (6.10) > 0 \qquad (6.11)^{17}$$

For each step, the increase in utility is calculated along the lines provided by (6.8). Step j which does not increase this level is left out when determining total planned net investments, i_D, as

$$i_D = \sum_{i=1}^{j-1} a_i \qquad (6.12)$$

Finally, the lag of one period between planned and actual purchase of investment goods leads to

$$i = i_{D_{t-1}} + \delta k \tag{6.13}$$

for gross investments, i.

This alternative investment sector has the following properties.

- The decrease in expected production costs caused by one unit of investments declines when k^e_{t+1} approaches k^* (i.e., when |gap| declines). This implies a positive relationship between |gap| and i_D. In other words, net (dis)investments are larger if the cost minimizing capital stock is farther remote from the actual stock of capital.
- It implies the pleasant feature that of a small |gap| a larger proportion is 'closed' by net (dis)investments.[18]
- It entails a plausible asymmetry: a firm incurring losses (or modest profits) will be more anxious to reach the cost minimizing stock of capital than a firm making (higher) profits. That is why we will label equation (6.8) 'the asymmetric investment function'.

As stated above, however, these features will not be illustrated and their consequences will not be discussed before Chapter 7, Section 3B.
For the remainder of the present chapter, we restrict ourselves to more traditional, symmetrical, investment assumptions, namely, the one where net investments equal an exogenous part (here set at 1/4) of the gap between the stock of capital that is expected to minimize production costs (k^*) and the one expected if no net investments would be undertaken.
What will be the implications for the patterns of adjustment if we postulate this investment function?
See next section, Section 2.

Section 2. The global patterns of adjustment / some simulations

In this section the following impulses will be described:
a. increase in government expenditures;
b. increase in wage rate;
c. monetary policy;
d. supply-side policy.
These impulses are analyzed assuming a non-vertical supply curve. Moreover, in Subsection e we will briefly discuss the vertical branch of the supply curve.

a. Increase in government expenditures;

Assumption: no monetary sector

If in the initial starting position as reflected by Table 6a.1 demand rises in a model not explicitly containing a monetary sector, it is known from Chapter 5 that this will immediately be followed by an increase both in output and in the output price level. As a consequence, expected nominal demand also increases, causing a rise both in expected supply and in the expected output price level. The former (increase in y^e) implies an outward shift of the isoquant, pushing k^* up. At given y^e, this increase in k^* is mitigated by the latter (increase in P_y^e) as an increase in the expected price level implies an increase of the expected rental price of capital. As the 'gap' is positive, net investments will occur.
The capacity effect of those investments will first of all shift the expected supply curve to the right as soon as the expected macro-economic stock of capital starts to grow, which presses expected output prices down. This reduces k^* and hence narrows the 'gap'. The 'gap' also shrinks as a result of the net investments themselves. As soon as k^* falls below the expected stock of capital, the 'gap' turns negative and the above reasoning is reversed.
A long run equilibrium is established where actual and optimal stocks of capital coincide and, consequently, net investments are zero. Since by definition the 'optimal capital stock' equals the cost minimizing one, the long run equilibrium will as in Chapter 5 be characterized by a labour coefficient and a capital coefficient that have returned to their initial

levels.[19] Just as in that chapter, supply will adjust to increased demand at a price level determined by equation (5.7). See Tables 6a.2 with all countries increasing government purchases by 10%, and 6a.3 where only country one acts in this respect under a system of fixed exchange rates. In the latter table, the outside world receives part of the impulse as households in country one spend part of their increased income in those countries. If exchange rates float, this result is no longer obtained: see Table 6a.3' displaying the insulation feature of the model.

Assumptions: monetary sector, no ICM, fixed exchange rates

If the model does entail a monetary block, the rate of interest is expected to rise initially, if the impulse on demand is caused by an increase in government purchases, but only to a mild extent if compared to the complementarity case: the expansion in the government deficit is moderated by an immediate fall in the rate of unemployment and higher labour tax receipts. (Compare Tables 6b.2 and 6b.3 to Tables 4b.2 and 4b.3, respectively.) The initial rise in the rate of interest will be followed by a further rise as soon as investments start to grow.

With a higher rate of interest, the optimal capital stock falls. As a result it will cet. par. take more time for supply to adjust to increased demand. As in Chapter 4, however, these movements in the rate of interest do not change the outcomes of the adjustment process.

Meanwhile, as Table 6b.2 illustrates, although net investments equal only 25% of the 'gap', due to the relatively large changes in k^* and thus in investments, still the positive relation between (actual) stock of capital and employment is blurred. This relation was established in Appendix 5.1 under the assumption that non-consumer demand does not change. In period 5 in Table 6b.2, for example, k rises but ℓ_m falls. The latter is explained by the drop in demand for investment purposes.

Moreover, the resulting higher rate of unemployment in that period causes the government deficit to grow (more social security benefits, lower labour tax revenue). This delays the fall in interest rates until the period where disinvestments are actually carried out.

Comparison of Tables 4a.2 and 4a.3 with 6a.2 and 6a.3, and of Tables 4b.2 and 4b.3 with 6b.2 and 6b.3 shows, that the differences between those

tables are found in the short run and not in the long run. In other words, the different investment and production functions do alter the way to, but not the location of the new point of equilibrium if the impulse concerns a government expenditure increase.

Assumptions: monetary sector, no ICM, flexible exchange rates

This conclusion also holds if flexible rates of exchange are assumed. Also here we find that freely floating exchange rates insulate the economy as long as no international mobility of capital is assumed. Table 6b.3' shows the outcomes for the intervening country to be identical to the situation where nothing of the impulse "leaked away" (as in Table 6b.2).

Assumptions: monetary sector, ICM, fixed exchange rates

Even the problems with the stability of the model if international mobility of capital is included are similar to those found in Chapter 4. A country increasing its government deficit attracts foreign capital financing part of that deficit. The service on this extra debt (interest payments) go in part to other countries and is taxed in those other countries. The intervening country thus subsidizes the governments of the other countries. See Table 6c.1 where, assuming fixed exchange rates, country one embarks upon extra government purchases. By period 200 the government deficit in that country is 10 times higher than in the other countries, with obvious consequences for the interest rate differentials and the levels of investment activity.

Remedies for these long term problems and a more detailed analysis of the short term and medium term impacts of the intervention were presented in Chapter 4. Here, as a main point it suffices to state that in the impulse period, as could be expected, the interest rate in the home country does not rise as much as in the situation of no capital mobility (compare Table 6b.3). As a result, k^* is now higher and more net investments are undertaken. In the first periods the process of adaptation much resembles the one found in Table 6b.3. The greater investment activity causes the expected capital stock to grow and thus expected output prices to fall, reducing the incentive to invest. But the difference emerges when after period 10 the rate of interest does not fall as it did without capital mobility. As indicated above, the reason lies in the strongly growing

deficit on the government account. As a result, the expected price of capital grows. This growth is reinforced as, due to the disinvestments, expected output falls, forcing expected output prices up. Whereas by period 200 the home country "ends up" with increasing government deficits, rising interest rates, increasing divestments, a shrinking stock of capital, falling production and an increasing rate of unemployment, in the outside world the opposite phenomena can be observed. And by no means can this period be labelled "the end", as will be remembered from Chapter 4.

Assumptions: monetary sector, ICM, flexible exchange rates

Alternatively, a system of floating rates of exchange could be adhered to. See Table 6c.1'.[20] An interesting difference between this table and the one discussed above lies in the shorter run. As usual, the expansion of the home government deficit in the impulse period causes the interest rate to rise, but with an identical impulse now more than in Table 6c.1. The rising interest rate calls for an appreciation of the home currency, which in turn harms the export position and with it total output. As a result unemployment will fall by less, causing the shortage on the government account to rise more steeply. So in the short run, the system of flexible exchange rates causes the government deficit (and with it the rate of interest) to rise faster. Meanwhile, the fiscal expansion causes the exchange rate to appreciate on the short run.

As a result of the higher rate of interest, but especially as a consequence of the lower rate of growth in final demand (determining the one expected in investments and thus the expected macro-economic stock of capital), k^* falls (relative to 6c.1).

As in Table 4c.7, after a few periods (in the table in period 5), the home currency starts to depreciate. One major reason is that the previous surpluses on the capital account result in an increasing deficit on the debt service account. A few periods later, this depreciation invokes expected depreciations, mitigating the capital inflow. A similar pattern evolves in the monetary sphere as in Table 4c.7. This prevents the rate of interest from rising continuously as it did with fixed exchange rates (Table 6c.1 above). As a result, neither the optimal stock of capital or total production will fall as it did in the previous table. But once more, period 200 cannot be regarded as the long run outcome.

b. Increase in wages.

Assumptions: no monetary sector, world-wide impulse

A world-wide increase in wages will be neutral with regard to the 'optimal' capital stock. This is due to the fact that the expected output price increase equals the increase in expected labour costs - analogous to $\dot{P}_y = \dot{P}_L$ both in the previous and in the present chapter. This has two effects.

First, expected output in real terms does not change.

Second, since the expected rental price of capital, given zero interest rates, moves proportionately with the expected output price level, the ratio between the expected factor prices does not change either.

Since both effects dictate the cost minimizing capital stock to stay at the original level, real net investments will not occur. Because, as shown in Chapter 5, the other variables will not change either, Table 6a.4 illustrates that no impact at all is to be expected from this impulse, except for a one time price increase.

Assumptions: no monetary sector, unilateral impulse, flexible exchange rates

The same conclusion holds for a unilateral wage impulse with flexible exchange rates and no monetary sector. This impulse, as seen before, leads to a production price increase in the home country equal to the depreciation. Consequently, consumers will not shift from home products to imported goods, nor vice versa. All prices (of goods and factors) will move proportionately. This also holds for expected prices. Therefore no net (dis)investments can be expected here, which is confirmed by inspection of Table 6a.6.

Assumptions: no monetary sector, unilateral impulse, fixed exchange rates

With fixed exchange rates, however, the deteriorated competitive position leads to a decline in the demand for goods produced by country one. See Table 6a.5. As a consequence, just as the rise in the actual output price level falls short of the rise in marginal production costs ($\dot{P}_y < \dot{P}_L$), the expected output price rise (caused by higher nominal demand) and with it

the expected price of capital will be lower than the expected labour price increase ($\dot{P}^e_y < \dot{P}^e_L$). As such, this would at given output increase the 'optimal' capital stock. But expected output will for the same reason fall. As shown in Appendix 6.1, the second effect outweighs the first, pushing the optimal stock of capital down. In the impulse period this effect is reinforced by a drop in the expected capital stock, due to a drop in real final (export) demand. The latter causes expected investments to fall with it, pressing the expected stock of capital down.

A negative gap results, producing net disinvestments. In the subsequent periods two opposite effects on k^* can be expected: the divestments in the impulse period will cause a drop in the expected capital stock (see equation 6A.2) and as such a fall in k^*. But at the same time, the capacity effect of the disinvestments will force the ratio P^e_y/P^e_L up, pushing k^* up again. For the model to reach a new equilibrium, the second effect should after some time outweigh the first, reversing the trend from divestments to net investments.

In the long run equilibrium condition (5.7) holds again with output prices that have gone up by the impulse percentage. Volumes will equal those found in the new equilibrium in Table 5a.5. Only the path to this new equilibrium diverges. Abroad, the effects boil down to the effects of a demand impulse, this time financed in the home country.

Assumptions: monetary sector, world-wide impulse

If a monetary sector is included, however, the impacts are different.

As illustrated in Table 6b.4, a world-wide increase in wages will no longer be neutral to investments. The main reason is that prices expected for period t+1 (the period where investment plans are carried out) do not rise as much as output prices and labour costs expected for t+2. As neither P^e_y/P^e_L nor k^e deviate from their starting levels, the same will be true of y^e. But the other determinant of k^*, expected relative factor prices, does change: P^e_k (depending on $P^e_{y_{t+1}}$) rises by less than P^e_L. As labour is expected to be the relatively more expensive production factor, in their strive for cost reduction, entrepreneurs will decide to expand their capital stock. The rise in the optimal stock of capital (k^*) will be attenuated by the increase in the rate of interest attributable to the

higher government deficit. The latter is caused by the increased salaries of civil servants and social welfare benefits.

Together with the 'automatic' drop in nominal expected demand, the consequent increase in y^e will in the subsequent periods force expected output prices down which, in turn, will temper the expectations with regard to output again. This leads to a decline in k^*. At the same time the actual capital stock starts to rise. This narrows the 'gap' between k^* and the expected capital stock. As soon as that gap turns negative, the process of investments is replaced by a process of divestments.

In the long run, the overall wage impulse is neutral with regard to all real variables. The same result was (immediately) reached without monetary block (Table 6a.4). The exception regards profits. In the long run they reach a value of 1 (rounded), an inheritance from period 2, where sales, labour costs and depreciation charges all rise by 10% but net interest paid is unaffected.

Assumptions: monetary sector, no ICM, unilateral impulse, fixed exchange rates

If under a system of fixed exchange rates but no international mobility of capital only one country faces an upward shift in the wage rate, with a monetary sector it will take more time before the downturn in k^* is (partly) reversed if compared to the description above pertaining to the economy without such an explicit monetary block. This delay is caused by the upward movement in the rate of interest invoked by the enlarged government deficit. The higher interest rate will on the one hand raise the expected price of capital and thus lower k^*. On the other hand, the enlarged deficit on the government account is now financed (for 50%) at a higher rate of interest, increasing future interest obligations by that government, a consequently higher deficit, etc. This destabilizing element (over time partly or completely offset by the smaller supply of bonds by firms), together with the one given above without a monetary block, should be outweighed by the stabilizing one (lower expected real labour costs) for the model to reach a stationary equilibrium again. Inspection of Table 6b.5 teaches us that ultimately this equilibrium will indeed be reached. It is hard to compare its numerical outcomes to the ones in Table 6a.5,

especially since in the first the period of reference on which expectations are based (as far as they are of a extrapolative nature) is twice as long. As a result a 10% shock in wages, for example, influences expected values less dramatically than if this period is shorter. So, the drop in expected output (and with it in the optimal capital stock) is lower in Table 6b.5 than it is in Table 6a.5. In both tables, however, prices of goods and production factors all end up 10% higher in the home country (and are restored abroad), and the initial capital/labour ratio is restored. Moreover, in both tables the new equilibrium is characterized by lower output and employment at home and increased output and employment abroad. As stated before, a wage impulse in country one functions as a demand impulse for the other countries.

Assumptions: monetary sector, no ICM, unilateral impulse, flexible exchange rates

If mobility of capital is still not assumed, the system of flexible exchange rates still ensures insulation if wage rates fluctuate.

As a result, the table concerned if no explicit monetary sector is included (Table 6a.6) was identical for the home country to the one where wages were manipulated in all countries (6a.4). If a monetary sector is included, the same holds: for the home country the results of Table 6b.5' equal those in 6b.4. In both instances (Table 6a.6 and Table 6b.5', respectively) the only impact on the outside world pertains to the overall price level. This goes up as a result of higher import prices.

Meanwhile, the exchange rate of the home country 'overshoots' its long run value after the impulse period if a monetary sector is included. The reason lies in the non-neutrality of an (overall) wage impulse under these circumstances. As a result of increased investments, household income rises with a consequent influence on import demand. This leads to a depreciation of the currency. As soon as 'the gap' is narrowed, investments fall and with it the demand for imports by families and the rate of exchange. Another factor influencing the exchange rate is the price level in the home country influenced by changes in the capital stock (among other items).

Assumptions: monetary sector, ICM, unilateral impulse, fixed exchange rates

The picture drawn above changes drastically, if international mobility of capital is assumed.

For the case of fixed exchange rates the outcomes presented in Table 6c.2 should be compared to those in Table 6b.5. In the beginning the differences are of a gradual nature. As capital is now mobile, the home interest rate rises less than it used to do. As a result, with an equal expected output price for t+1 and for t+2, the expected price of capital rises less, dampening the drop in k^*, which causes disinvestments to fall as well.[21] The important difference with the above tables, however, lies in the longer run, where as usual the country enlarging its government deficit is faced with a deficit running out of hand. (The reasons for this phenomenon and the way to remedy this instability were given in Chapter 4 and repeated above).

As in Table 6c.1 this leads to strongly rising interest rates in the home country and minimal interest rates abroad. The impacts on the respective optimal stocks of capital are obvious.

Assumptions: monetary sector, ICM, unilateral impulse, flexible exchange rates

These results can be compared to the ones regarding the same impulse, also assuming international mobility of capital but flexible rates of exchange. See Table 6c.2'.

In compliance with Table 4c.10, the rate of interest in the home country no longer rises "drastically": the depreciation (invoked by the drop in exports and increase in imports) ensures that the value of foreign demand for home bonds measured in home currency rises (as their currency is more worth now). Nevertheless, on balance the substantial extra supply of bonds by the (home) government makes the interest rate go up.[22] As in Table 4c.10, the depreciation ultimately leads to a foreign interest rate that exceeds the one in the home country. In the same way as the depreciation increases the value (in currency one) of foreign holdings of bonds issued in one (OVD21), it decreases the value of country one's holdings of foreign assets in currency two (OVD12). As a result foreign rates of interest go up as well.

The main consequences of the wage rate increase, however, remain: falling output (and increasing unemployment) as a result of lower exports. But the depreciation attenuates this fall. Expected output does not drop as fast as it did with fixed exchange rates (Table 6c.2). Added to the lower rate of interest (causing a smaller increase in the expected price of capital), k^* will not fall as sharply and disinvestments will not be as large as with fixed rates of exchange.

In the outside world the rise in exports and production is tempered by the depreciation of currency one. As a consequence, expected output and the optimal stock of capital do not grow as sharply as they did in Table 6c.2 with fixed rates of exchange. The latter's growth is also (mildly) mitigated by the rise in foreign interest rates.

In the subsequent period, the home currency depreciates further. If exchange rates of period 2 had also prevailed in period 3, the deficit in the trade balance would have been about constant, whereas the service account would be in deficit and the surplus on the capital account would have fallen drastically.[23]

To keep the total balance of payments in equilibrium, the currency depreciates, forcing the deficit on the trade balance down and the surplus on the service account and the capital account up, relative to the case of no adjustment in exchange rates.[24] The depreciation stimulates exports and total output if compared to Table 6c.2 (fixed exchange rates).

Concluding, in the first periods the depreciation of the home currency prevents output and expected output to fall as hard as would have been the case without exchange rate adjustment. This causes divestments to be smaller, which results in 'higher' expected output and a 'higher' optimal stock of capital.

The depreciation, however, declines each period: because of the depreciation, the trade deficit declines each period and with it the need for a counter balancing positive service account and capital account. And since the depreciation falls, in the course of time the expected depreciation drops, too (here in period 9, see RMERE 12). This tempers the expected profitability of capital exports and thereby the need for the currency to depreciate.

Meanwhile, interest rates are not fixed. In the home country, additions to wealth (interest receipts and net profits) are larger, inducing wealth to grow faster. At the same time, the gap between the government deficit in the home country and its counterpart abroad falls (because of higher profit and interest tax receipts). Together with the divestments resulting from the wage increase and the increase in wealth signaled above, this implies that the extent to which the home interest rate exceeds the one abroad, growing in the first eight periods, is forced down in subsequent periods. Given the immediate stock adjustment nature of international portfolio transactions, cet. par. this would have led to a deficit on the capital account. In periods 9 and 10 this deficit does not yet occur because of the still positive expected depreciation and the depreciation itself. But as period 200 indicates, after period 10 this deficit does indeed emerge. The consequences of this capital export are impressive. By period 200 the picture is dominated by the consequently positive service account. This balance is responsible for the large appreciation of the home currency. As a result, exports and with it home production have shrunk and unemployment has grown dramatically. Abroad, the picture is reversed: a high level of exports and production caused by a cheap currency.

Once more, the outcomes of an impulse in the longer run appear to be dominated by the service account.

c. Monetary policy

Assumptions: monetary sector, world-wide impulse

If all countries expand their stock of money, the rate of interest will fall, which lowers the rental price of capital. Cost minimization will make entrepreneurs decide to invest in net terms: k^* rises. This case is illustrated in Table 6b.6.

When carrying out their plans (in t=3), their extra supply of bonds drives the rate of interest up. On the other hand, the government deficit falls as a result of increased employment and lower interest obligations. This smaller deficit constitutes a lower need of funds. Depending on the parameters (as α_1), the rate of interest will rise or fall. In the present table it rises. The other component of the rental price of capital ($P^e_{y_{t+1}}$)

will fall as soon as expected output rises sufficiently. The latter increases as a result of the invoked investment activity itself. The consequent fall in expected capital costs makes k^* rise further. If the model is to return to a stationary equilibrium, the other determinant of k^* (y^e) should fall after some time and outweigh this substitution effect. As the table illustrates, virtually all variables do indeed return to their initial position.

Assumptions: monetary sector, no ICM, unilateral impulse, fixed exchange rates

If only one country increases its money stock, without international mobility of capital and assuming fixed rates of exchange, it can by and large expect the above consequences adjusted for temporary demand impulses. See Table 6b.7. The increased investment activity will drive home output prices up and deteriorate its competitive position. Exports will fall constituting a negative demand impulse. As soon as the stock of capital has grown sufficiently, output prices fall and improve the home country's competitive position. As a result exports rise, which constitutes a positive impulse on demand. Moreover, as a result of increased household income, imports will rise. The latter implies increased economic activity abroad. The analysis of the consequences of this impulse for foreign countries follows the lines of a demand increase not financed by the government, however, and of a temporary nature. Due to the temporary nature of the 'added' impulse, total long run outcomes in all countries resemble those of Table 6b.6, which again equal those of the non-intervention case, except for welfare: during the adjustment process prices are moving slightly, unemployment first goes down in all countries concerned, interest rates are lower in the intervening country (temporary) and, as a consequence, especially government interest obligations in those countries are lower.

Assumptions: monetary sector, no ICM, unilateral impulse, flexible exchange rates

If flexible rates of exchange are assumed, but still no international mobility of capital, Table 6b.7' confirms the insulation feature familiar by now from previous tables. In other words, the outside world is not

influenced and the intervening country experiences the same impacts it would have if all countries had acted simultaneously in the same respect. This also implies that for exports to drop along with home consumer demand (as it did in Table 6b.6), the depreciation should be slightly lower than the production price increase. In the long run, for exports to return to their initial level, this depreciation on balance vanishes.

Assumptions: monetary sector, ICM, unilateral impulse, fixed exchange rates

If the assumption of international immobility of capital is dropped, the neutrality of monetary policy in the long run signaled above is questioned.

With fixed rates of exchange the process leading to instability known from above reappears. The country with the lower government deficit is, after some time, subsidized by the other governments. In this case (see Table 6c.3) the former is country one expanding its money supply. The consequent fall in the home rate of interest (which is of course smaller than without mobility of capital, compare Table 6b.7) exceeds the one abroad. As a result the optimal stock of capital at home rises by more than in other countries, which invokes a higher expansion of investments in country one. In the short and medium term a pattern of adaptation seems to emerge that mirrors (qualitatively speaking) the one without international capital mobility. The expansion at home may be larger than the one abroad but in the first years no signs of conflict arise.

However, beneath the surface Table 6c.3 shows areas of developing conflict. The capital outflow out of country one in the impulse period causes a positive balance on the debt service account in the subsequent periods. Moreover, in period 3 the home country administration faces lower interest obligations (OG1)[25] pressing its budget deficit down. In the outside world, however, this deficit is rising due to lower interest proceeds and thus a lower profit tax revenue. So, the interest rate differential between the home country and the outside world widens, giving rise to a further capital outflow and to a larger debt service account surplus in the subsequent periods. Money invested abroad yields interest to be paid abroad but taxed in the home country: the familiar destabilizing cycle.

By period 200 the interest rate in the home country has fallen to its minimum.[26] The optimal stock of capital is therefore very high, and the same is true of the actual number of machines. The latter implies that investment demand not only for net investments but also for replacement purposes[27] is very high. So high, that the variable 'model' equals zero: the economy in the home country faces a zero rate of unemployment.

Assumptions: monetary sector, ICM, unilateral impulse, flexible exchange rates

If capital is mobile internationally, and exchange rates are flexible, the pattern is much more synchronous in the various countries. See Table 6c.3'.

In the impulse period the Mundell-Fleming scheme holds: monetary policy is more effective now (if compared to Table 6c.3) due to the depreciation (induced by the capital outflow) that stimulates exports and thus output in the home country. Less well known are the impacts on employment abroad: the same depreciation makes exports by the other countries (to the home country) more difficult, which harms output and employment. So, in the short run monetary policy is conflicting.

But conflicts disappear in time. At the new rates of interest and the new rates of exchange (established in period 2), portfolios would be in equilibrium in period 3, ceteris paribus. Hence, the immediate reaction in the monetary sphere would result in zero capital flows in the next rounds, ceteris paribus. But the depreciation in the home country calls for further expected exchange rate depreciations, and hence a further capital flight out of the home country.[28] This drives the home rate of interest up.

Moreover, the service account (positive in the impulse period because of the depreciation itself) will now be positively influenced by the previous capital outflow out of country one. As such, this calls for a (gradual) appreciation of the home currency. As soon as the value of that currency exceeds its initial value (between periods 7 and 8), exports fall and imports rise on balance (both by country one). About simultaneously, total output abroad has on balance risen.

The actual appreciation mitigates the expectations of a depreciating home currency. So, the capital account shortage of the home country declines in every period .

Period 200 is in several respects the opposite of period 2: a home currency that has on balance appreciated, the home country is harmed by its expansionary policy (less production and employment), it is faced with a higher government deficit, its interest rate exceeds the one abroad (abroad this rate falls short of its initial level, at home it exceeds this level), and, last but not least, it has a (large) capital account surplus and a vast deficit on the service account.
All of these elements show how dangerous it is to look only at the short run effects of monetary policy.[29]

d. Supply-side policy

As long as international mobility of capital is excluded, a supply-side policy cannot be expected to be really effective with the present investment equation, even if profits are positive. Since such a policy does not change the optimal stock of capital, investments will not change. Without a monetary sector, the only effect will then be a lowering of tax proceeds, but one can hardly call this the main objective of a supply-side policy. This conclusion can be verified by comparing Tables 6a.2 and 6a.7 for a model excluding a monetary sector.[30]
Essentially, it remains valid if a monetary sector is included as far as T_R refers to the tax rate on profits. In this situation all possible effects (see below) are caused by a change in the rate of interest. In fact, one could question whether such effects are really what is intended by "supply-side policy". Nevertheless, what are the consequences of this type of policy if a monetary block is included?

Assumptions: monetary sector, world-wide impulse
Under these circumstances, the decrease in the tax rate, besides increasing the government deficit, speeds up the growth in wealth. See Table 6b.8. As seen before, if no international capital mobility is assumed (given rates of interest) 50% of the extra wealth is invested in (home)

bonds, just as 50% of the increased deficit of the administration is financed by bonds. On balance, the tax rate reduction does not influence the rate of interest. As a result k^* also remains unaffected and the tax rate policy is ineffective.[31]

Assumptions: monetary sector, ICM, unilateral impulse

This picture changes, however, with international mobility of capital. In that case, the extra need of funds by government is only partly met by an increased demand for bonds issued in the home country as wealth grows only in country 1. As a result, the home rate of interest rises and the capital balance displays a deficit.[32] The rising rate of interest in the home country causes a fall in the optimal stock of capital in the home country in the short run. As a result of the capital export out of country one, the interest rate abroad falls and the optimal stock of capital rises in the short run.

With fixed rates of exchange (see Table 6c.4) the familiar picture of a government in the home country subsidized by the other countries emerges. Its interest rate falls to extremely low levels in the longer run. The effects on the optimal (and with it on the actual) stock of capital are obvious: although on the short run the fall in the profit and interest tax is counterproductive, in the long run it is not.

With flexible rates of exchange (see Table 6c.4') the home currency initially depreciates as a result of the capital account deficit. In the longer run, however, the consequent service account surplus is 'translated' into an appreciation, harming output and expected output. As a result, the optimal capital stock in the longer run falls in the home country. So, both in the short and the longer run,[33] for the home country the tax rate policy discourages investments. Abroad, however, investments are stimulated.

e. A note on the vertical branch of the supply curve

As described, with an upward sloping supply curve (the situation described above) a demand increasing policy will stimulate investments. In a supply model (i.e., with a vertical supply schedule caused by the bottleneck

labour), however, such a policy is counterproductive with regard to investments, which is explained as follows. Given technical coefficients, output is determined by the availability of labour and capital. The same holds for expected output, the first determinant of 'optimal' k. An increased demand for products does not alter this determinant. It does, however, change expected nominal demand (which goes up), increasing the expected prices of products and thus the rental price of capital.[34] The 'optimal' capital stock will therefore fall and so will investments. Moreover, since investments fall, the expected capital stock will decline, causing a decline of expected output in the subsequent periods, which constitutes a second negative impetus on investments.

This conclusion, formally derived in Appendix 6.1, is contrary to what was found in the previous chapters. There, production price increases on balance benefitted investments by increasing expected profits, or at least did not harm them.[35] In the present situation, however, net investments would be harmed via an increase in the rental price of capital.

This feature is illustrated by a comparison between Tables 6a.8 and 6a.9, both assuming a model without monetary sector. In Table 6a.8 'model' switches to zero -indicating a vertical supply curve- as a result of a (world-wide) labour tax reduction by 4%-points. A stationary situation is reached in period 62. This also holds in Table 6a.9 where the same impulse is complemented by an increase (also world-wide) in government expenditures. But in 6a.9 the higher nominal expected output value given rigid expected supply, causes higher expected output prices and capital costs, and therefore lowers investments. Arguments can be raised here in favour of models where the output price level is distinct from the buying price of machines.

Appendix 6.1. Effects on the optimal capital stock (k^*) if no monetary sector is included

If, both actually and expected, the supply curve runs upward (as opposed to vertically), the following equations apply (disregarding $\beta_0 = 1$).

$$y^e = k^e \times \left[\beta \frac{P_y^e}{P_L^e} \right]^{\frac{\beta}{1-\beta}} \tag{6A.1}$$

where $k^e = k + i_t^e - i_{t-\vartheta} + i_{t+1}^e - i_{t-\vartheta+1}$ (6A.2)

with $i_{t+1}^e = FA' \times i_t^e$
(FA' = expected rate of growth in real final demand)
and $i_t^e = i_{D_{-1}} + \delta k$.

$$k^* = \frac{y^e}{\left[\frac{\beta}{1-\beta} * \frac{P_k^e}{P_L^e} \right]^{\beta}} \tag{6A.3}$$

where, without monetary sector, $P_k^e = \delta P_y^e$.
This set of equations leads to the following expression for k^*.

$$k^* = C\, k^e \left[\frac{P_y^e}{P_L^e} \right]^{\frac{\beta^2}{1-\beta}} \tag{6A.4}$$

with $C = (\beta)^{\frac{\beta}{1-\beta}} \left(\frac{\beta}{1-\beta} \cdot \delta \right)^{-\beta} > 0.$

Since $0 < \beta < 1$, in (6A.4) the exponent $\frac{\beta^2}{1-\beta}$ is positive. Therefore we can conclude:

1. given k^e, a rise in $\frac{P_y^e}{P_L^e}$ causes k^* to go up. In other words, if $\frac{P_y^e}{P_L^e}$ rises, the increase in expected sales (i.e., the move to a higher isoquant) in its effect on k^* more than offsets the negative substitution effect on k^* given by the denominator of (6A.3);
2. given $\frac{P_y^e}{P_L^e}$, a fall (rise) in the expected stock of capital, k^e, leads to a proportionate fall (rise) in k^*.

If, however, the supply curve is vertical, (6A.1) is replaced by

$$y^e = (\ell_{mmax})^{\beta}(k^e)^{1-\beta} \tag{6A.5}$$

As a result,

$$k^* = C'(k^e)^{1-\beta}\left[\frac{P_y^e}{P_L^e}\right]^{-\beta}(\ell_{mmax})^{\beta} \tag{6A.6}$$

with $C' = (\frac{\beta}{1-\beta}\delta)^{-\beta} > 0$.

So, with a vertical supply curve and given ℓ_{mmax} we can conclude:

1. given k^e, since the move to a higher "expected isoquant" is absent, a rise in $\frac{P_y^e}{P_L^e}$ will cause a fall in k^* due to the substitution effect (and vice versa);
2. given $\frac{P_y^e}{P_L^e}$, a fall (rise) in the expected stock of capital, k^e, causes a less than proportionate fall (rise) in k^*.

Moreover, if available labour supply rises, the optimal capital stock rises but less than proportionately.

NOTES (Chapter 6)

1 See Richard W. Kopcke, "The Determinants of Investment Spending", New England Economic Review, July/August 1985; Dale W. Jorgenson, American Economic Review, vol.53, May 1963, "Topics in Economic Theory", pp.247-259; E.M. Claassen,"Grundlagen der Makroökonomische Theorie", 1980; F. Scotland, "Investment: A Survey of Models with some implications for the effects of Monetary Policy", Technical Report 29, Bank of Canada, Dec. 1981.

2 J. Gould and R. Waud, "The Neoclassical Model of Investment Behavior: Another View", International Economic Review, vol. 14, no. 1, Febr. 1973, pp.33 - 48.

3 Since there is a one period installment lag of new capital goods and an identical time lag between investment decisions and the actual investment (see Chapter 4), all expectations discussed here refer to the expected values for two years after the current decision to invest, unless otherwise indicated. This also holds for the capital stock expected to minimize production costs, k^*. Technical coefficients, however, are assumed constant over time. In the derivation here we leave out the word 'expected'. Moreover, in the equations below, for convenience we leave out β_0 (=1).

4 Once k^* is determined, the gap (between actual and production cost minimizing stocks of capital) is known. It would be technically possible to calculate for each coming year ($< t + \Theta$) a new k^*.
With non-stationary economies, however, this would result in Θ different 'gaps', as well. In line with literature at this point, we choose to let the computer calculate one gap only, partly or completely to be filled by net investments. The next period, on the basis of new information, a new gap is determined invoking new decisions to invest or disinvest.

5 P^e_L is calculated as discussed in Chapter 2. If a value expected for the next period is symbolized by the suffix "t+1" , P^e_k is calculated as $P^e_k = r^e * P^e_{y,t+1} + \delta * P^e_y$, as interest charges are calculated over the expected price of the machine concerned that applies on the day of purchase, i.e., interest is calculated over the price expected for t + 1. Note that r^e was assumed to equal r.

6 In the remainder, when we speak of 'the gap' we refer to this definition.

7 In Claassen (ibid) this fraction is endogenous if the extra investment demand pushes up the price of capital goods, reducing the profitability of extra investments. This approach is not suited for the SIER model as we assume perfect competition in product markets.

8 This observation remains valid if A > B: the case of net disinvestments.

9 Since rho is the 'net' rate of return, that is after allowing for financing charges, the return on bonds does not provide an indication here.

10 F.Hartog, 'Hoofdlijnen van de Prijstheorie', Leiden, 1979, p.225.

11 More capital involved means higher discomfort since more money is at stake in an uncertain (risky) world.

12 C_2 should be such that the factor in brackets is positive. The coefficients and parameters in (6.8) are set to produce "acceptable" results (see Chapter 7, section 3B). As such, they are as arbitrary as an exogenous rho, for example.

13 Actually, the computer splits OC up in 200 equal parts. Each of these parts are regarded as successive marginal increases.

14 This illustrates the very limited role the 'gap' plays in determining actual investment decisions in this version. Mainly it serves two functions. Firstly, it prescribes whether there will be net investments or disinvestments, depending on the sign of the 'gap'.
Secondly, it serves as the upper limit for net (dis)investment decisions. Besides this, it determines the magnitude of a_i. See below.

15 Equal to $0.005 \times (k^*-k)$. That is i = 1, 2, 3, ... 200. For convenience, the description in the main text is restricted to $a_i > 0$, but the resulting formulas also apply to $a_i < 0$.

16 Since $1-1/\beta < 0$, the expression in [ ] and thus the outcome of (6.9), the reduction in labour costs, is positive for $a > 0$ and negative for $a < 0$, given P_L^e, $y^e > 0$.

17 A policy raising the rate of interest, or rather the expected price of capital, raises (6.10). Consequently, (6.11) drops, reducing total investments.

18 This is pleasant, since, as stated earlier, k^* can fluctate quite sharply. If a constant fraction of the resulting gap (or even a proportion increasing with gap) were invested, this could lead to a disappointing variability in investments.

19 As the starting position is stationary if no interventions occur, in that starting position the actual and the production cost minimizing capital stock coincide.

20 In this and other tables assuming flexible rates of exchange that follow, model 597 is used. With the model used when playing (592), the computer was incapable of finding acceptable results for the number of periods required here. Model 597 differs from 592 in the sense that the prices of gold in countries 2 and 3 are not estimated by the computer, but are set equal to the one in country 4. The latter was used as the numeraire throughout. As a consequence, model 597 included $ER_2 = ER_3 = ER_4 = 1$ where ER_j indicates the price of gold in currency j. Model 597 is only used if only country 1 intervenes treating the other countries undiscriminatively. It was not used in previous chapters. (See however Chapter 4, Section 4C.)

21 In the outside world the interest rates seem to be unaffected. As OP2 in period t=3 rises if compared to the situation of no intervention, this can only be caused by rounding.

22 In Table 4c.10 it actually fell as a result of a smaller increase in the government deficit. The latter, in turn, is due to the complementarity assumption where in the short run unemployment does not change (as opposed to the developments with substitutable factors of production where unemployment rises immediately).

23 S1N would have been -1.38, KOB1 would have been -0.04 and KAB1 would have dropped to 0.38. These figures are not shown in the table.

24 See also Chapter 4, Table 4c.10.

25 Expansionary open market policy was defined as substitution of government bonds by money.

26 OVD11/V1 = 2%.

27 Or rather, autonomous investments equal to δk.

28 To see this, compare OVD12/V1 to OVD21/V2. The former exceeds the second while $r_1 > r_2$. After subtraction of "RMERE12" (expected depreciation of home currency) $r_1 < r_2$.

29 To be sure, period 200 does not resemble a long run equilibrium, either.

30 It also holds if only one country acted in this respect.

31 If combined with other impulses, the rate of interest does not necessarily equal its initial 10% level. In that case only approximately 50% of wealth is invested in bonds and this conclusion does not hold exactly.

32 Caused by the same increased wealth in the home country.

33 Although model 597 was used here, the computer stops at round 162. With an (absolutely) lower impulse, it can compute 'more rounds'.

34 This also holds if a monetary sector is included, when the impetus on demand leads to a rising interest rate, as will normally be the case with extra bond financed government expenditures.

35 Net investments were zero in Chapter 4, if labour was expected to be scarce.

Chapter 7 The SIER Game as a framework for research

Introduction

In the present chapter it will be argued that the SIER Game cannot only be used fruitfully for educational purposes, but also as a powerful framework for research. In each of the three sections of this chapter, one type of research will be illustrated. The examples that will follow are no more than illustrations of what can be researched with the help of the SIER framework and are not claimed to be fully completed research projects.

We will illustrate the following research possibilities:

1. Section 1 Leave the game as described in Chapters 2 to 6 and use it to calculate and compare effects of policy interventions in alternative settings. The SIER Game contains various types of policies (hiring extra civil servants, import tariff policies, etc.). To illustrate this first research possibility, we will summarize and compare some of the effects of fiscal policy, wage policy, supply-side policy and monetary policy calculated in the previous chapters.
We will draw some conclusions on the efficacy of these policies and compare the conclusions on monetary and fiscal policy to standard textbook predictions.
Moreover, we will give some preliminary indications on the possibilities for international harmonization, cooperation and conflict connected with the respective policies considered here.

2. Section 2 Leave the game behavioural assumptions in the model as they were described in Chapters 2 to 6 and compare the effects of policy interventions to those found in more advanced literature based on models applying other (behavioural) assumptions. As an example we will compare the predictions of the SIER framework to those of an article by Sachs.

3. Section 3 Change assumptions in the SIER framework to include alternative (behavioural) assumptions. If the latter are borrowed from existing literature, it is possible to check whether or not the conclusions drawn in the text considered also hold in the SIER framework. As an example, in Section 3A we will include assumptions made in a recent contribution by Van Wijnbergen to see if (some of) his major conclusions also hold in the

adjusted model. Moreover, in Section 3B we will illustrate some effects of the asymmetric investment behaviour discussed in Chapter 6 that, although incorporated into the basic SIER Game, cannot be regarded to be a part of standard economic theory. Those effects can be compared to the ones found when applying the standard symmetric investment function used in the remainder of Chapter 6.

Section 1 Effects of some policies in the SIER Game, an overview and comparison with textbook predictions

If we want to draw some conclusions on the possibilities of international cooperation vs. conflict in this context, we have to make an assumption on the goals of economic policy of the respective governments. To simplify, it is assumed here that governments strive for maximal (private) production and employment.[1] Alternatively, one could assume, for example, that they strive for price stability or even for 'maximal welfare' as defined in Chapter 1.[2]

Moreover, the terminology should be defined.
First of all, a unilaterally undertaken policy can be internationally "sustaining", "neutral" or "conflicting". That is, a policy intervention by country 1 while improving employment and production in the intervening country can benefit production (and employment) in the other countries, can leave it unaffected or can lower it, respectively.
Secondly, the outside countries will follow country one's policy (or will act simultaneously) if this is in their interest, that is, if production and employment in their countries will be larger if they join country one's action than if they just "consume" the spillover effects of country one's intervention. In that case, "harmonization of policies"[3] results, i.e., world-wide equal policies without (necessary) international consultations.[4]
Finally, "coordination of policies" will be found where a gain in production and employment can only be reached if all countries act simultaneously, in other words, if without international consultations no (positive) gain can be reached.

Tables 7.1 to 7.4[5] provide an overview of the effects on private production and employment of expansionary fiscal policy (7.1), wage policy (7.2), supply-side policy (7.3) and monetary policy (7.4) in alternative settings within the SIER framework.

Each table reports the effects of intervention under the assumptions of Chapters 3, 4, 5 and 6, respectively, where per chapter (a) only a real sector is included, (b) a monetary sector is also included but no international capital mobility or (c) both a monetary sector and international mobility of capital are included. For reasons explained in those chapters, the figures dealing with Chapters 3 and 5 relate to part (a) only . Each table contains 3 columns:

column 1: all countries intervening simultaneously, also to be referred to as a multilateral action;

column 2: an intervention in country 1 only, also to be referred to as a unilateral action, assuming fixed rates of exchange;

column 3: an intervention in country 1 only, assuming flexible rates of exchange.

The effects reported concern those in period 2 (t=2, the "immediate" effects), in period 4 (t=4, where "the short run" refers to period 2 and/or 4) and the long run. The latter is defined as the new equilibrium position where real variables and the rate of interest no longer change. For reasons given in Chapter 4, figures relating to part c do not concern that long run position but relate to period 200 (unless otherwise indicated), labelled "the longer run".

Below, we will simply list conclusions that can be directly drawn on the basis of Tables 7.1 - 7.4. The explanations of the figures and trends signaled are partly found in the chapter concerned. The remaining explanations often require further research. The same holds for the comparisons with standard literature. A more completed research project would compare the conclusions with more advanced and more recent contributions, as well. It is repeated that this section (as well as the other parts of this chapter) is only meant as an illustration of what could be researched with the SIER framework.

Unless otherwise indicated, the conclusions only hold for the reported periods and not for the periods in between.

Finally, as before, we abbreviate international (portfolio) capital mobility as ICM.

Conclusions pertaining to all four tables:

1. Without ICM, flexible exchange rates insulate the intervening country. If insulation applies, it holds both in the short and in the long run. It implies that there is no incentive or disincentive for the home country (country 1) to seek international coordination: its policy actions affect its economy to the same extent as if the policy was carried out multilaterally.[6] As the outside countries do not reap the benefits of such an intervention, they are likely to join country 1: if the effects are positive, country 1 acts and the others will join; in other cases, country 1 will not act and neither will the other countries. If so, harmonization of policies is the result.
In other words, without ICM and with flexible rates of exchange, harmonization of policies is likely.

2. If factors of production are complementary, possible reactions in output and/or employment cannot occur until 2 periods after the impulse, whereas with substitutable production factors, such reactions can occur immediately.

3. If ICM is excluded and unemployment is positive, the long run outcomes of impulses are not influenced by the shape of the production function (complementarity vs. perfect substitution) or by the shape of the investment function. The differences are only found in the short (and intermediate) run. In other words, the new equilibrium as such is not affected by the choice of the production function or by the choice of the investment function, although the path towards that new equilibrium may be influenced.[7]

With regard to (expansionary) fiscal policy, the following conclusions can be drawn from Table 7.1.

1. If the action is world-wide, production is enhanced both in the short run and in the long run. Employment also grows, unless labour was already scarce (Chapter 5).

2. If only country 1 acts, without ICM, it can expect an increase in production and employment both in the short and in the long run.

3. Although fiscal policy is traditionally assumed to be internationally sustaining, this assumption is not necessarily valid, especially not if consumers react slowly to changing relative prices (see column 2, Table 3a3[8]) or if capital is mobile (same column, Table 4c2). In those cases fiscal policy is conflicting in the short run. Neither does the assumption hold if initially unemployment equals zero (Chapter 5), in which case the policy is neutral.[9]

4. If exchange rates are fixed, the long run expansionary effects of fiscal policy are smaller if the country acts alone than if all countries act alike (or if exchange rates float). On the short run, however, the former (individual action) exceed the latter (concerted action) if factors of production are complementary. The reverse holds if factors of production are substitutable.
In other words, when embarking upon fiscal policy, a country faced with complementarity between its factors of production would in the short run be better off or equally well off without internationally harmonized policies. But in the long run, as well as if its production factors are substitutable, it benefits if the other countries join.[10]
In the outside world, the spillover effects of country one's policy without ICM (and with ICM on the short run) are smaller than the effects they would perceive if they would indeed join. Hence, without ICM, international unification of policies is likely in those cases.
If capital is mobile and exchange rates are fixed, in the (true) long run the outside world may be better off without their own action.[11] If so, a conflict arises within these countries: harmonization is better in the short run, but not in the long run.

5. On the impact of ICM on the effects of fiscal policy:
The efficacy of fiscal policy is unaffected in the impulse period if factors of production are complementary. If they are substitutable, the same holds if exchange rates are fixed. But if exchange rates float, ICM tempers the expansionary impact on the home country and establishes an influence on outside countries. In other words, with substitution, ICM breaks the insulation immediately.
With fixed rates of exchange, ICM enhances the short run (t=4) impact of fiscal policy on the home economy at the expense of its influence on outside economies. With flexible rates of exchange, the opposite can be noted: ICM mitigates the expansionary impact in the home country whereas the impact on the other countries is enhanced.
In as far as period 200 is indicative for the long run, in the long run capital mobility reduces the impact on the economy of the intervening country and stimulates its impact abroad, both if exchange rates are fixed and if they float.

6. On the short run (t=2 and t=4) the introduction of ICM and/or an alternative exchange rate system does not affect the impact of fiscal policy on total world output or world employment, but only their distribution over the respective economies.[12] The same conclusion holds in the long run for an alternative exchange rate system provided ICM is excluded. If capital is mobile, introduction of flexible as opposed to fixed exchange rates reduces the long run impact of a unilateral fiscal expansion on world output and employment.

7. Without ICM an expansionary fiscal policy causes the currency to depreciate in the short as well as in the long run, where with possibilities of substitution between production factors the exchange rate depreciates earlier and sharper. An exception is the case of zero unemployment with substitution (Chapter 5), where the exchange rate does not move at all.
If capital is mobile internationally, the fiscal policy causes the currency to appreciate.
In the periods and cases reported, the currency does not in the short run overshoot or undershoot its long run value except for the case of Chapter

6 (substitution between factors of production and investments directly determined by the cost minimizing capital stock) if ICM is excluded.

Some of the above conclusions can be compared to the ones found in standard literature.
The SIER models as depicted in Chapters 2 to 6 can be classified as large country models based on perfect national competition, but imperfect international competition (both in product and production factor markets, as well as in bond markets, if included) and assuming sterilization of the monetary consequences of imbalances on the trade account[13] (but not of those on the capital account or on the debt service account). This must be borne in mind if its 'predictions' are compared to those of other models.

Without ICM

Mundell and Fleming claim that without ICM, fiscal policy would be ineffective if exchange rates are fixed, but more effective if exchange rates float. That flexibility of exchange rates makes fiscal policy more efficient is by and large confirmed in our setting.[14]
If exchange rates are fixed and ICM is excluded, both Mundell-Fleming and Frenkel and Mussa[15] claim that fiscal policy is ineffective. The former argue that a fiscal expansion causes a shortage on the balance of payments and, consequently, a reduction of the money supply until the initial production level is restored. Frenkel and Mussa argue that in small countries and with capital immobile, following purchasing power parity, prices in the home country are determined by the fixed prices in the outside world and the exchange rate. As a consequence, output is not affected, either.
The inefficacy of fiscal policy if capital is immobile, as claimed by both pairs of researchers, is not upheld in our model(s). The large country assumption, the (internationally) imperfectly working product markets as well as the accomodating monetary policy are crucial in explaining these differences.

With ICM

Mundell-Fleming states that with capital mobile, fiscal policy would be ineffective with flexible exchange rates, due to the invoked appreciation.

Frenkel and Mussa add as an argument here that with flexible rates of exchange, money demand is fixed as it equals the (fixed) money supply. So, the determinants of money demand (nominal output) must be fixed as well. In our model the latter assumption is abandoned. With capital (imperfectly) mobile, fiscal policy is effective, although less effective than without ICM and on the short run less effective than with fixed exchange rates. In the longer run it is even more effective than with fixed exchange rates. A distinction between the short and long term efficacy, as made by Caves and Jones[16] (p.431) seems appropriate here, especially since the service account grows in importance over time (see Chapters 4 and 6). Moreover, as the short run impacts of fiscal policy appear to depend on the macro-economic production function and the investment function, for example, and as the long run effects may depend on the tax rate system,[17] for example, the simple classifications "effective" or "ineffective" need further qualification.

Table 7.2 on wage increasing policies[18] leads to the following conclusions.

1. A world-wide increase in wages has neither an immediate (t=2) nor a long run impact on production and employment. On the short run (t=4), however, employment and production rise if and only if a monetary sector is included. This conclusion also holds if insulation applies (see above).

2. If wages rise in one country only and exchange rates are fixed, in the short run[19] its production and employment fall. In the long run these targets deteriorate even further. Production and employment in the other countries benefit.[20]
An exception to this rule is the situation where consumers react slowly to changing relative prices, where in the short run the intervening country benefits and the outside world is harmed. Also in this exceptional case, however, home employment and production deteriorate in the long run, whereas their counterparts in the outside world improve.

3. With fixed rates of exchange, the immediate effects (t=2) are not influenced by the shape of the investment function or by inclusion of ICM.

4. Inclusion of ICM worsens the long run production and employment effects for the intervening country if it increases its wage rate. It benefits long run production and employment in the outside countries.[21]

5. If consumers react immediately to changing relative prices, in none of the reported periods is world output or world employment lowered by a wage increasing policy in one or more countries.
World output and world employment grow in the short (t=4) and in the long run if one country raises its wage rate under a system of fixed exchange rates.
Crucial here is the assumption that all household incomes rise. If government wages do not rise simultaneously, the present conclusion is invalidated. See the figures taken from Table 5a14, for example.

6. Without ICM, a wage increasing policy leads to a depreciation of the currency if exchange rates float. If capital is mobile, however, the same policy leads to a depreciation in the short run (t=2 and t=4), but to an appreciation in the long run.
In all cases where a monetary sector is included, the currency overshoots its long(er) run value.

Table 7.3 deals with a 10% point reduction in the tax rate on profits and interest receipts. As footnote 1 to this table indicates, for models excluding ICM a government expenditure increase of 10% is added to generate profits and hence to make a tax reduction potentially effective.[22] Thus, parts a and b of Table 7.3 should be compared to their counterparts of Table 7.1. This is not necessary in part c (ICM), as in that case the tax reduction is the sole intervention.

The following conclusions can be drawn on the basis of Table 7.3:

1. If all countries act simultaneously, immediate as well as long run effects of tax reduction are absent. In the short run (t=4), however, production and employment grow, unless investments are determined by the cost minimizing capital stock (Chapter 6), where short run output and employment effects are also absent.

2. For models excluding ICM, the following can be noted (with regard to unilateral interventions).
In the long run a tax cut is ineffective.
If factors of production are complementary, output and employment in the intervening country are improved in the short run (t=4). The extent to which they are improved is independent of the exchange rate system.[23]
With complementarity the tax policy can be labelled "neutral" in all reported periods.
With possibilities of substitution, the influence on the short run depends on the investment function and the exchange rate system.
If investments are determined by the cost minimizing stock of capital, no impact of the tax cut is found (like on the long run). Likewise in this case the tax policy is "neutral". But if investments depend on lagged profits (Chapter 5) and exchange rates are fixed, the immediate effects (t=2) on output and employment in the home country are beneficial, whereas they are disadvantageous for the other countries ("conflicting"). Two periods later, however, production in the home country is still higher than without tax reduction, but employment is lower and foreign output is on balance unaffected while employment has even grown. As a consequence, the tax reduction is on balance beneficial in that period for outside countries, whereas the intervening country will experience advantages as well as disadvantages. As previously indicated, in the long run all effects will have disappeared.

3. For models including capital mobility, Table 7.3 leads to the following conclusions with regard to a unilateral intervention.
With fixed exchange rates the intervening country harms its short run ($t<5$) output and employment levels by a tax reduction, but improves their values in the long(er) run. The outside world benefits in both respects in the short run,[24] but is harmed in its output level in the longer run. Its longer run employment worsens if factors of production are complementary, but improves if these factors are substitutable.
With flexible rates of exchange, by and large the opposite effects can be expected: it will be beneficial for the intervening country in the short

run, but unbeneficial in the longer run; and for the outside world: unbeneficial in the short run,[25] but beneficial in the long run. (All effects: with regard to both output and employment.)

The answer to the harmonization question now becomes quite complicated. If the outside countries are interested in reaping short term benefits, they will decide to act multilaterally if exchange rates are flexible and will refrain from doing so if exchange rates are fixed. If they have a long(er) time horizon, with flexible exchange rates they will not join country 1 in its tax reduction, but with fixed exchange rates and complementary factors of production they will cut their taxes, too. If a long time horizon is combined with fixed exchange rates and substitutable factors of production, however, their answer depends on the priority they give to production vs. employment.

In short, whether or not with ICM a tax cut is likely to be an internationally harmonized policy depends on the exchange rate system, on the time horizon of policy makers and on the shape of the macro-economic production function.

Table 7.4 dealing with a one time monetary expansion leads to the following conclusions.

1. Without ICM the monetary expansion (unilateral or world-wide) is ineffective in the long run.

2. In the short run (t=4) it can be concluded
- that a monetary policy positively influences output and employment in the intervening country/countries;
- that a world-wide action is as least as advantageous for an acting country as an unilateral intervention with fixed exchange rates or else without ICM;
- that in the latter situation (fixed exchange rates or else no ICM) non-intervening countries are not harmed (the policy is either neutral or sustaining), but are worse off than if they join country 1 in its expansion;

- that in that situation harmonization of the monetary policy is therefore likely and not disadvantageous for any country (This conclusion does not hold in the long run, however. See below).

3. If ICM is included and exchange rates are fixed,
- in the long(er) run an unilaterally intervening country gains more in output and employment than with a multilateral intervention; the outside countries, however, gain employment but lose output in that same period;
- in the latter sense the monetary policy is conflicting in the long run although exchange rates are fixed;
- as a result the other countries will harmonize their policies if they want to avoid the long run production loss (or want to gain more in the short run, see conclusion 2), although the initiating country (country 1) will dislike this if its time horizon is long run (as opposed to short run).

4. If ICM is included and exchange rates float,
- the monetary policy is conflicting in the short run;
- outside countries gain in the long(er) run, whereas the initiating country loses in the same period, but gained in the short run;
- the latter gain in the short run is higher than with a concerted action;
- in the long run the outside world gains from an action by the home country (country 1);
- hence, if politicians have a short time horizon, harmonization will result and those at home will dislike it; if they have a long time horizon, harmonization will <u>not</u> result and home politicians will not like it either.

5. If exchange rates float, the currency of the country expanding its money supply overshoots its long run value in all cases reported.

6. If exchange rates are fixed, the introduction of ICM does not alter the short run influence of the monetary policy on world output and employment. But it alters the impact on these variables if exchange rates float.

Standard literature claims that in a small country with fixed exchange rates monetary policy is ineffective, both with and without ICM (international capital mobility, see above). Frenkel and Mussa (ibid) add that for a larger country the inefficacy might be alleviated: without ICM the exogenous character of prices (dictated by the world market) would be questioned. To that extent monetary policy would gain efficacy and with ICM, rates of interest would no longer be completely exogenous.
Caves and Jones (ibid, p.431) label monetary policy ineffective both without ICM as well as in the short run with ICM. Following Frenkel and Mussa, they label it "less ineffective" in the longer run with ICM.
Table 7.4 illustrates that without ICM monetary policy is also ineffective in the long run in the SIER framework.[26] But it is not ineffective in the short run. Moreover, in our model it is effective with ICM both in the short and in the long run.

With flexible rates of exchange in general the above sources claim monetary policy to be effective (depreciation), both with and without ICM, although Frenkel and Mussa argue that in the longer run its efficacy will be limited by an increased demand for imported products (caused by the higher income).
Table 7.4 shows that also in our setting the home currency depreciates and production and employment rise in the intervening country in the short run. Without ICM, however, production and employment (and exchange rates) are in the long run restored to their initial levels, leaving the (one time) open market policy ineffective. And with ICM, in the longer run the currency has on balance appreciated making the policy counterproductive for the intervening country.

As with fiscal policy, the different conclusions can to a large extent be explained by the differences in assumptions as summarized under the heading 'fiscal policy'. But we must also conclude that in standard literature too little attention is paid to the role the service account can play, especially in determining the long run efficacy of macro-economic policy.

Table 7.1. Effects of fiscal policy, overview (notes: see end of table)

Multilateral (G_i = 10%)					Unilateral (G_1 = 10%)								
					Fixed exchange rates					Flexible exchange rates			
Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run
3a2	$y=\ell m$	100	100.084	100.590	3a3[1]	$y_1=\ell m_1$	100	100.143	100.568	3a5	$y_1=\ell m_1$	100	100.084	100.590
						$y_2=\ell m_2$	100	99.98	100.007		$y_2=\ell m_2$	100	100	100
											ER12	1	1.00013	1.00094
					3a4[2]	$y_1=\ell m_1$	100	100.084	100.568					
						$y_2=\ell m_2$	100	100	100.007					
4a2	$y=\ell m$	100	100.084	100.590	4a3	$y_1=\ell m_1$	100	100.084	100.568	4a6'	$y_1=\ell m_1$	100	100.084	100.590
						$y_2=\ell m_2$	100	100	100.007		$y_2=\ell m_2$	100	100	100
											ER12	1	1.00013	1.00094
4b2	$y=\ell m$	100	100.232	101.799	4b3	$y_1=\ell m_1$	100	100.232	101.742	3)	$y_1=\ell m_1$	100	100.232	101.799
						$y_2=\ell m_2$	100	100	100.019		$y_2=\ell m_2$	100	100	100
											ER12	1	1.00037	1.00288
					4c2	$y_1=\ell m_1$	100	100.234	99.990[4)5)]	4c7	$y_1=\ell m_1$	100	100.218	101.553[4)5)]
						$y_2=\ell m_2$	100	99.999	100.667[4)6)]		$y_2=\ell m_2$	100	100.005	100.088[4)6)]
											ER12	0.99434	0.99391	0.99190
Chapter 5a[11)]														
5a2	y	100.385	100.406	100.590	5a3	y_1	100.374	100.394	100.568	5a3'	y_1	100.385	100.406	100.590
	ℓm	100.482	100.504	100.590		ℓm_1	100.468	100.498	100.568		ℓm_1	100.482	100.504	100.590
						y_2	100.004	100.004	100.007		y_2	100	100	100
						ℓm_2	100.005	100.005	100.007		ℓm_2	100	100	100
											ER12	1.00077	1.00081	1.00094

Table 7.1. Effects of fiscal policy, overview (continued)

Multilateral (G_i = 10%)					Unilateral (G_1 = 10%)								
					Fixed exchange rates					Flexible exchange rates			
Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run
Chapter 5a[12)]														
5a9[7)]	y	100	100.016	136.175[8)]	3)7)9)	y_1	100	100.016	136.175[8)]	3)7)9)	y_1	100	100.016	136.175
	ℓm	100	100	100		ℓm_1	100	100	100		ℓm_1	100	100	100
						y_2	100	100	100		y_2	100	100	100
						ℓm_2	100	100	100		ℓm_2	100	100	100
											ER12	1	1	1
6a2	y	100.385	100.579	100.590	6a3	y_1	100.374	100.556	100.568	6a3'	y_1	100.385	100.579	100.590
	ℓm	100.482	100.692	100.590		ℓm_1	100.468	100.664	100.568		ℓm_1	100.482	100.692	100.590
						y_2	100.004	100.008	100.007		y_2	100	100	100
						ℓm_2	100.005	100.009	100.007		ℓm_2	100	100	100
											ER12	1.00077	1.00111	1.00094
6b2	y	101.350	101.848	101.799	6b3	y_1	101.310	101.777	101.742	6b3'	y_1	101.350	101.848	101.799
	ℓm	101.691	102.221	101.799		ℓm_1	101.641	102.134	101.742		ℓm_1	101.691	102.221	101.799
						y_2	100.013	100.024	100.019		y_2	100	100	100
						ℓm_2	100.017	100.029	100.019		ℓm_2	100	100	100
											ER12	1.00271	1.00355	1.00288

Multilateral (G_i = 10%)				Unilateral (G_1 = 10%)								
				Fixed exchange rates					Flexible exchange rates			
Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run
					6c1	y_1	101.310	101.784	98.578[4)5)]	6c1'	y_1	101.299	101.748	101.624[4)5)]
						ℓm_1	101.641	102.143	100.891[4)5)]		ℓm_1	101.627	102.099	101.619[4)5)]
						y_2	100.013	100.021	101.361[4)6)]		y_2	100.017	100.033	100.063[4)6)]
						ℓm_2	100.017	100.026	100.483[4)6)]		ℓm_2	100.021	100.041	100.061[4)6)]
											ER12	0.99924	0.99797	0.99394

Notes (Table 7.1):

1) Imports depending upon lagged prices
2) Imports depending upon current prices
3) Not included in previous tables, calculated separately
4) period 200
5) decreasing from t=200 to t=201
6) increasing from t=200 to t=201
7) increase in G = 9.375%
8) value in t=1000, increasing from t=1000 to t=1001
9) As labour income is constant and prices are constant abroad, imports by country one are constant and nothing leaks away. The trade balance is zero with fixed exchange rates, implying that with floating exchange rates, these rates are constant and the two alternative systems lead to identical results.
10) not included in a previous table; calculated separately11) rising (not vertical) supply curve
12) vertical supply curve (zero unemployment)

Table 7.2. Effects of wage policy, overview (notes: see end of table)

Multilateral (P_{Li} = 10%)					Unilateral (P_{L1} = 10%)								
					Fixed exchange rates					Flexible exchange rates			
Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run
3a6	$y=\ell m$	100	100	100	3a7[1]	$y_1=\ell m_1$	100	100.448	97.959	3a9	$y_1=\ell m_1$	100	100	100
						$y_2=\ell m_2$	100	99.847	100.749		$y_2=\ell m_2$	100	100	100
											ER12	1.1	1.1	1.1
					3a8[2]	$y_1=\ell m_1$	100	99.687	97.959					
						$y_2=\ell m_2$	100	100.111	100.748					
4a4	$y=\ell m$	100	100	100	4a5	$y_1=\ell m_1$	100	99.670	97.959	4a5'	$y_1=\ell m_1$	100	100	100
						$y_2=\ell m_2$	100	100.112	100.749		$y_2=\ell m_2$	100	100	100
											ER12	1.1[3]	1.1[3]	1.1[3]
4b4	$y=\ell m$	100	100.019	100	4b5	$y_1=\ell m_1$	100	99.760	98.210	4b5'	$y_1=\ell m_1$	100	100.019	100
						$y_2=\ell m_2$	100	100.089	100.656		$y_2=\ell m_2$	100	100	100
											ER12	1.1	1.10003	1.1
					4c4	$y_1=\ell m_1$	100	99.761	93.312[4]	4c10	$y_1=\ell m_1$	100	99.901	97.696[4]
						$y_2=\ell m_2$	100	100.089	103.750[4]		$y_2=\ell m_2$	100	100.037	100.874[4]
											ER12	1.00796	1.01756	0.91346[4]
5a4	y	100	100	100	5a5	y_1	98.651	98.581	97.959	5a6	y_1	100	100	100
	ℓm	100	100	100		ℓm_1	98.317	98.243	97.959		ℓm_1	100	100	100
						y_2	100.493	100.519	100.749		y_2	100	100	100
						ℓm_2	100.617	100.644	100.749		ℓm_2	100	100	100
											ER12	1.1	1.1	1.1

Multilateral (P_{Li} = 10%)					Unilateral (P_{L1} = 10%)								
					Fixed exchange rates					Flexible exchange rates			
Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run
5a13[5]	y	100	100	100										
	ℓm	100	100	100										
5a14[6]	y	98.666	98.594	97.963										
	ℓm	98.335	98.259	97.963										
6a4	y	100	100	100	6a5	y_1	98.651	97.995	97.959	6a6	y_1	100	100	100
	ℓm	100	100	100		ℓm_1	98.317	97.614	97.959		ℓm_1	100	100	100
						y_2	100.493	100.731	100.749		y_2	100	100	100
						ℓm_2	100.617	100.872	100.749		ℓm_2	100	100	100
											ER12	1.1	1.1	1.1
6b4	y	100	100.201	100	6b5	y_1	98.651	98.298	98.210	6b5'	y_1	100	100.201	100
	ℓm	100	100.211	100		ℓm_1	98.317	97.938	98.210		ℓm_1	100	100.211	100
						y_2	100.493	100.691	100.656		y_2	100	100	100
						ℓm_2	100.617	100.828	100.656		ℓm_2	100	100	100
											ER12	1.1	1.10034	1.1

Table 7.2. Effects of wage policy, overview (continued)

Multilateral (P_{Li} = 10%)				Unilateral (P_{L1} = 10%)								
				Fixed exchange rates					Flexible exchange rates			
Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run
					6c2	y_1	98.651	98.338	92.633[4]	6c2'	y_1	98.775	98.858	95.198
						ℓm_1	98.317	97.982	97.224[4]		ℓm_1	98.472	98.618	95.071[4]
						y_2	100.493	100.677	121.443[4]		y_2	100.444	100.474	102.168[4]
						ℓm_2	100.617	100.812	103.750[4]		ℓm_2	100.555	100.563	102.203[4]
											ER12	1.00918	1.03296	0.82613[4]

Notes (Table 7.2):
1) imports depending on lagged prices
2) imports depending on current prices
3) not included in previous table, calculated separately
4) period 200
5) with vertical supply curve: all wages and unemployment benefits rise
6) with vertical supply curve: only private wages rise

Table 7.3. Effects of a decrease in the tax rate on profits and interest proceeds of 10%-points.[1] (notes: see end of table)

Multilateral					Unilateral								
					Fixed exchange rates					Flexible exchange rates			
Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run
Chapter 3a														
2)	$y=\ell m$	100	100.105	100.590	2)11)	$y_1=\ell m_1$	100	100.105	100.568	3a10	$y_1=\ell m_1$	100	100.105	100.590
						$y_2=\ell m_2$	100	100	100.007		$y_2=\ell m_2$	100	100	100
Chapter 4a														
2)	$y=\ell m$	100	100.105	100.590	2)	$y_1=\ell m_1$	100	100.105	100.568	4a6	$y_1=\ell m_1$	100	100.105	100.590
						$y_2=\ell m_2$	100	100	100.007		$y_2=\ell m_2$	100	100	100
Chapter 4b														
2)	$y=\ell m$	100	100.288	101.799	2)	$y_1=\ell m_1$	100	100.288	101.742	2)	$y_1=\ell m_1$	100	100.288	101.799
						$y_2=\ell m_2$	100	100	100.019		$y_2=\ell m_2$	100	100	100
Chapter 4c					4c5	$y_1=\ell m_1$	100	99.999	103.626[4)5)]	4c9	$y_1=\ell m_1$	100	100.001	93.447[4)6)]
						$y_2=\ell m_2$	100	100[3)]	98.594[4)5)]		$y_2=\ell m_2$	100	100[7)]	103.200[4)5)]
Chapter 5a[12)]														
5a7	y	100.385	100.412	100.590	2)	y_1	100.400	100.398	100.568	2)	y_1	100.385	100.412	100.590
	ℓm	100.482	100.510	100.590		ℓm_1	100.500	100.493	100.568		ℓm_1	100.482	100.510	100.590
						y_2	99.995	100.004	100.007		y_2	100	100	100
						ℓm_2	99.994	100.006	100.007		ℓm_2	100	100	100

Table 7.3. Effects of a decrease in the tax rate on profits and interest proceeds of 10%-points.[1] (continued)

Multilateral					Unilateral								
					Fixed exchange rates					Flexible exchange rates			
Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run
Chapter 6a														
6a7	y	100.385	100.579	100.590	2)	y_1	100.374	100.556	100.568	2)	y_1	100.385	100.579	100.590
	ℓm	100.482	100.692	100.590		ℓm_1	100.468	100.664	100.568		ℓm_1	100.482	100.692	100.590
						y_2	100.004	100.008	100.007		y_2	100	100	100
						ℓm_2	100.005	100.009	100.007		ℓm_2	100	100	100
Chapter 6b														
2)	y	101.350	101.848	101.799	6b8	y_1	101.310	101.777	101.742	2)	y_1	101.350	101.848	101.799
	ℓm	101.691	102.221	101.799		ℓm_1	101.641	102.134	101.742		ℓm_1	101.691	102.221	101.799
						y_2	100.013	100.024	100.019		y_2	100	100	100
						ℓm_2	100.017	100.029	100.019		ℓm_2	100	100	100
Chapter 6c					6c4	y_1	100	99.984	110.360[4)5)]	6c4'	y_1	100.017	100.039	89.135[8)]
						ℓm_1	100	99.982	103.750[4)]		ℓm_1	100.021	100.049	90.773[8)]
						y_2	100	100.005	98.672[4)5)]		y_2	99.994	99.987	105.048[9)]
						ℓm_2	100	100.006	103.750[4)]		ℓm_2	99.993	99.984	103.750[10)]

Notes: see next page.

Table 7.4. Effects of monetary policy, overview

Multilateral					Unilateral								
					Fixed exchange rates					Flexible exchange rates			
Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run	Table	value of	t=2	t=4	long run
4b6	$y=\ell m$	100	100.079	100	4b7	$y_1=\ell m_1$	100	100.079	100	4b7'	$y_1=\ell m_1$	100	100.079	100
						$y_2=\ell m_2$	100	100	100		$y_2=\ell m_2$	100	100	100
											ER12	1	1.00013	1
					4c3	$y_1=\ell m_1$	100	100.044	103.750[3]	2)	$y_1=\ell m_1$	100	100.392	96.670[3)4)]
						$y_2=\ell m_2$	100	100.012	100.053[3)4)]		$y_2=\ell m_2$	100	99.905	101.160[3)5)]
											ER12	1.12425	1.08116	0.89397[3)4)]
6b6	y	100	100.474	100	6b7	y_1	100	100.459	100	6b7'	y_1	100	100.474	100
	ℓm	100	100.506	100		ℓm_1	100	100.487	100		ℓm_1	100	100.506	100
						y_2	100	100.005	100		y_2	100	100	100
						ℓm_2	100	100.006	100		ℓm_2	100	100	100
											ER12	1	1.00081	1
					6c3	y_1	100	100.258	121.052[3)4)]	6c3'	y_1	100.961	100.878	99.0148[3)4)]
						ℓm_1	100	100.275	103.750[3)]		ℓm_1	101.203	100.955	99.403[3)4)]
						y_2	100	100.071	99.978[3)4)]		y_2	99.698	99.849	100.274[3)5)]
						ℓm_2	100	100.076	100.044[3)4)]		ℓm_2	99.623	99.828	100.188[3)5)]
											ER12	1.06503	1.04035	0.97331[3)4)]

Notes (Table 7.4):
1) increase in $\bar{M}\bar{P}$ of 10% in Tables regarding Chapter 4, increase in $\bar{M}\bar{P}$ of 5% in Tables regarding Chapter 6, all in t=2
2) not included in a previous table, calculated separately
3) value in t=200
4) increasing from t=200 to t=201
5) decreasing from t=200 to t=201

1) For models assuming international immobility of capital (parts a and b), the effects are reported of a decrease in profit taxes (TR) and an increase in material government expenditures of 10%. The latter is added to make profits emerge. As a result, to detect the impact of the tax manipulation, the outcomes should be compared to those in Table 7.1. If capital is mobile internationally (part c), the effects are a result of a fall in TR only and should be compared to the outcomes of "no intervention".
2) not included in previous table; calculated separately
3) $y_2 = \ell m_2$ rises in the medium term
4) period 200
5) increasing from t=200 to t=201
6) decreasing from t=200 to t=201
7) $y_2 = \ell m_2$ falls in the medium term
8) value in t=161; value falling from t=161 to t=162
9) value in t=162; value rising from t=161 to t=162
10) value in t=161 and t=162
11) immediate reaction of m/c to relative prices
12) rising (as opposed to vertical) supply curve

Section 2 Monetary and fiscal policy under nominal vs. real wage-rigidity

Introduction

Following Branson and Rotemberg,[27] Jeffrey Sachs[28] studies the impact of fiscal and monetary policy under nominal-wage and real-wage rigidity using a Mundell-Fleming (M-F) framework. He concludes that the efficacy of fiscal and monetary policy crucially depends on the way wages are set.
In this section it will be demonstrated that a similar analysis can be performed using the SIER framework.[29] We will adapt that framework only marginally and will show that the remaining differences between our model and the one applied by Sachs are sufficient to reach different conclusions. The efficacy of fiscal policy not only depends upon the wage assumption, but also on the way it is financed (Sachs assumes tax finance). 'Ricardian debt equivalence' is not obtained.

Sachs' assumptions and conclusions

According to Sachs, the traditional M-F conclusions under ICM and flexible exchange rates (monetary policy is effective since it leads to a depreciation, fiscal policy is less effective since it causes an appreciation) only hold if real wages can be altered by exchange rate movements. If the real wage is fixed, the M-F policy-ranking is reversed.
Sachs reaches this conclusion using a model assuming:

1. A small open economy with flexible rates of exchange, perfect capital mobility, perfect foresight (rational expectations) and perfect competition.
2. A neo-classical production function with substitutable factors of production (capital and labour) and a fixed capital stock.
3. A Metzler savings function. Savings (i.e., the current account surplus) are proportional to the gap between desired wealth and actual wealth. Wealth consists of foreign bonds only (home bonds and high powered money are ignored). Desired wealth is determined by net disposable income.

4. The government budget is balanced, extra government expenditures are tax financed. Private and public sector marginal propensities to import are equal.
5. Export and import demand are functions of output and the terms of trade only and Marshall-Lerner conditions are satisfied.
6. The share of domestic goods in domestic expenditures is constant.
7. The share of labour income in the value of output is constant.[30]

Four different assumptions on wage behaviour are made: fixed nominal wages, fixed real wages, lagged indexation of wages and real wages responding slowly to the gap between labour input and the long run desired labour supply (lagged Phillips mechanism).
These wage behaviours can be inserted into the the SIER model by choosing the proper coefficients in equation (2.14), the wage equation.

Sachs' most important conclusions as far as the short run is concerned (i.e., ignoring changes in wealth), are as follows.
1. Fiscal policy is effective with a fixed real wage and (as in M-F) ineffective when the nominal wage is fixed.
Fiscal policy causes an appreciation (in Sachs' model extra fiscal spending is financed by higher taxes, causing a lower disposable income, lower desired wealth, lower demand for foreign bonds and thus a surplus on the capital account). The appreciation forces consumer prices down.
With fixed nominal wages the appreciation (reducing exports) neutralizes the impact of fiscal policy. But if the wage rate (P_L) is lowered, too (indexation), product wages (to be defined as P_L / P_y) fall and a downward (outward) shift of the supply curve results.
If indexation occurs with a time lag, the fiscal multiplier is smaller in the short run than in the steady state. The impact multipliers may even be negative.[31]
With a lagged Phillips mechanism the rise in output leads to an increased demand for labour. As a result, real wages will begin to rise, which reduces the fiscal multiplier.
2. Monetary policy is ineffective with a fixed real wage and (as in M-F) effective if the nominal wage is fixed.

Expansion of the money supply causes a depreciation, rising import prices and thus inflation.
If the nominal wage adapts to this inflation (indexation), the rise in product wages (and thus the upward shift of the supply curve) compensates the extra demand.
If nominal wages are constant, output rises. If wages are indexed with a one period lag, monetary policy will be effective in the short run (P_L is constant); later (indexation), output returns to its initial level.
Sachs does not analyse the effects of a monetary expansion under a lagged Phillips mechanism.

As soon as the long-term wealth effects are taken into account, Sachs concludes the following.
With a fixed nominal wage, the long run multipliers of monetary and fiscal policy are both likely to be positive, unlike the M-F zero multiplier of fiscal policy. With real wage rigidity, the money multiplier is again zero, given the nominal-real dichotomy of the long run model.
The long run fiscal multiplier, however, is negative.
He explains this as follows. Under both wage assumptions, fiscal expansion raises output and leads to a current account deficit on impact. Actual bond wealth falls. This decline in wealth causes aggregate demand to fall. If real wages are rigid, the initial output level is reached and the trade account is again in balance. But the decline in wealth has moved the debt service account into deficit, and the overall current account remains in deficit. Output must decline still further in order to reduce imports thus balancing the debt service account deficit with a trade balance surplus.
If nominal wages are fixed, the decline in wealth is eventually accompanied by a depreciation of the currency (negative debt service account). Aggregate supply expands and competitiveness improves. Due to the latter, the current account is balanced at a higher level of output.

Sachs remarks that the above obtained results are very sensitive to the specification of the trade balance. As soon as the marginal propensity to import in the public sector is lower than the marginal propensity to import in the private sector, a balanced budget fiscal expansion will shift

demand from foreign to home produced goods. In that case, a fiscal expansion can increase output in the long run, even with rigid real wages.

Modifications of the SIER model

To facilitate impulses in the SIER model similar to those discussed by Sachs, the former is slightly modified in the following respects:

1. The possibility of equal private and public sector marginal propensities to import is created and used (unless otherwise indicated);[32]
2. To prevent calculation problems in case of immediate and full indexation, expenditures (on goods or on taxes) are assumed to depend on income earned in the previous period;[33]
3. Capital is made fixed (in line with Sachs' assumption). With investments fixed, one of the two transmission mechanisms in the SIER model (exchange rate and rate of interest) is skipped. In the Sachs model wealth also plays a role here.

After these modifications, the SIER model differs from the Sachs model in the following major respects:

1. Four countries of equal size instead of a small open economy.
2. Capital is not perfectly but imperfectly mobile.
3. Expectations are not 'rational', but are partially determined by the past.
4. Consumer demand is a function of net household income, wealth does not determine consumption.
5. The trade balance depends on labour income and relative prices.
6. Accomodated transactions demand for money.

When a monetary sector is included in the SIER model (which is appropriate here), a continuously growing government deficit results. Half of this "deficit according to trend" is financed by bonds, half is financed through monetary means. With a fiscal policy, we assume the extra governmental deficit is either:[34]

a. bond financed
b. money financed
c. tax financed.

In the last case no extra government deficit arises. To achieve this, the tax rate concerned changes each period as its basis, labour income, for example, changes. Three alternatives are distinguished here: profit tax financing, labour tax financing and a combination of profit and labour tax financing.

With a monetary policy we assume (for convenience) that the complete deficit is "half money, half bond" financed.

Simulations

In the full research project , the consequences of a unilateral monetary and fiscal expansion under the first three above mentioned wage regimes were analysed using the amended SIER model.[35] Although more conclusions were drawn, [36] for the sake of brevity we will at this point concentrate on the effects of monetary and especially fiscal policy in the short and in the longer run with nominal vs. real wage rigidity. With regard to (expansionary) fiscal policy, we will focus on the following claims made by Sachs :

1. In the short run (where wealth considerations do not yet play an important role) with nominal wage rigidity the appreciation makes fiscal policy ineffective, but (apart form direct impacts from wealth on demand, not present in the SIER model), with real wage rigidity it makes fiscal policy effective (through a price and wage decline);
2. In the long(er) run the depreciation caused by the shortage on the debt service account makes fiscal policy effective with constant nominal wages and ineffective (or even counterproductive) with constant real wages;
3. In the short run the efficacy of fiscal policy with nominal wage rigidity is lower than with real wage rigidity; in the long run the opposite holds.

Instead of inserting a new set of tables, the main lines of the results[37] are summarized in graphs.[38]

The first graph, Diagram 7.1, displays the effects of expansionary monetary policy. It shows that, in the short run, monetary policy will be

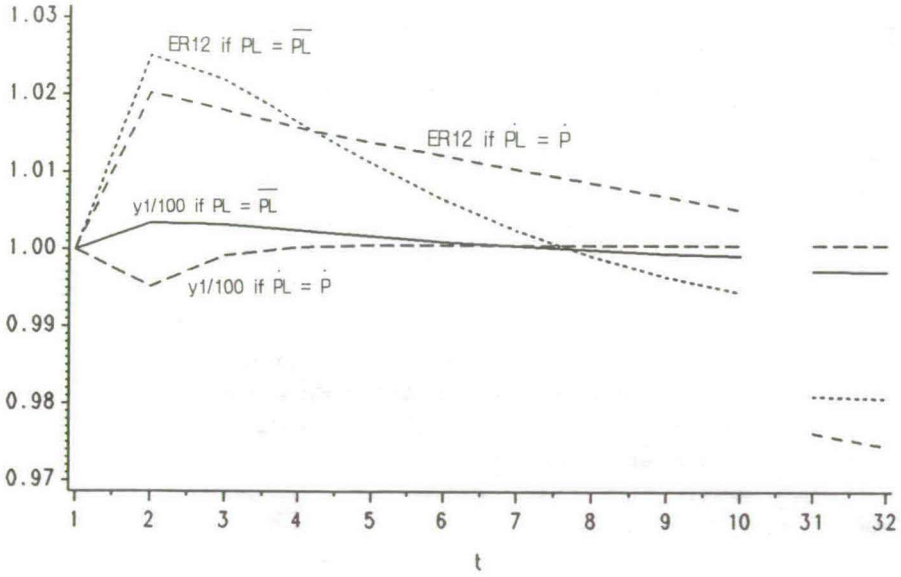

Diagram 7.1

most effective with sticky nominal wages, due to a depreciation of the currency (result of a deficit on the capital account) causing an increase in exports.

In the case of immediate indexation of wages, the depreciation causes the consumer price index to rise relative to the output price, forcing product wages up and output down.[39]

When wages are indexed with a time lag,[40] this is obtained one period later.

The capital balance deficit, however, leads to a debt service account surplus in the subsequent periods, leading to an appreciation of the exchange rate of country one.

With sticky nominal wages, this causes output to go down (falling exports). When wages are indexed immediately, output starts to grow, as a result of a falling product wage and increased household earnings in the impulse period. From period 7 onwards, output will even be higher than with rigid nominal wages.

If wages are indexed with a one period lag, output declines as soon as wages adjust to a consumer price increase. Due to the appreciation, output increases slightly, but remains below its initial level.

In summary, Sachs' conclusions for the short run are confirmed in the sense that monetary policy is expansionary with fixed nominal wages and (after a few periods) the effect is minimal with fixed real wages. But the continuous appreciations (caused by the service account surplus) indicate that in the longer run the policy is counterproductive with nominal wage rigidity and is more or less neutral with real wage rigidity.[41]

Whereas the latter is still in line with Sachs' findings, the former is not.

Monetary policy, with the exception of the impulse period, is the least effective in the case of lagged indexation of wages.

The true long run positions were not calculated, but considering the direction in which the exchange rate moves immediately after the impulse period, it is most likely that the exchange rate overshoots its long term equilibrium value, both with sticky nominal wages and with immediate indexation.[42]

The effects of an expansionary fiscal policy of 10% are summarized in Diagram 7.2 where the extra deficit is bond financed.

In t=2, the interest rate in the intervening country rises causing the home currency to appreciate and forcing exports down. Nevertheless, on balance, output in country one rises, due to the increased demand for home produced goods by the government. The output price rises. Notwithstanding the appreciation, the consumer price level rises, too.

In Sachs' analysis (assuming tax finance), the consumer price index declines due to the appreciation. This difference in average price developments is crucial in determining whether indexation of wages will make fiscal policy more effective (as in Sachs' paper) or not.[43] With indexa-

tion, the price rise found in our model causes a rise in wages and consequently a fall in output. In other words, we find that indexation makes fiscal policy less effective in the short run if bond financing is assumed.

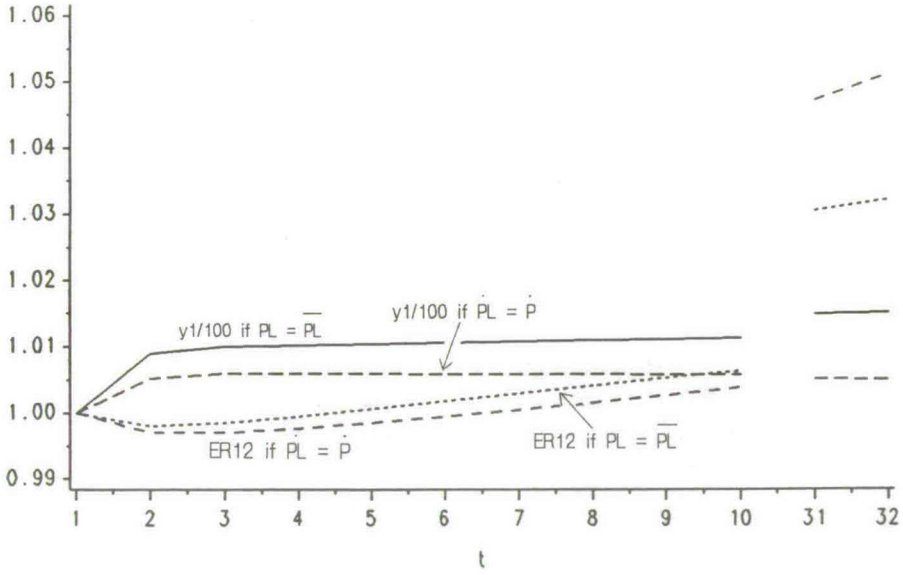

Diagram 7.2

In the subsequent periods the extra government deficit, partly financed by foreign portfolio investors, grows continuously (see Chapters 4 and 6). As a result, the international interest rate differential grows over time leading to growing capital inflows, followed by increasing shortages on the service account. And the latter lead to a continuously depreciating home currency. This mechanism is stronger with indexation as a depreciation in that case is followed by wage increases also paid to civil servants enlarging the government deficit. Moreover, with indexation a wage-price spiral develops causing a relatively large deficit on the trade account which enlarges the depreciation. The depreciations enhance the

efficacy of fiscal policy with rigid nominal wages, but hamper this efficacy with indexation.

Concluding, in the short run we find that bond financed fiscal policy is not ineffective and that indexation makes it less effective (contrary to Sachs). In the long(er) run indexation does make it less effective (in line with Sachs), but not ineffective or counterproductive (contrary to Sachs).

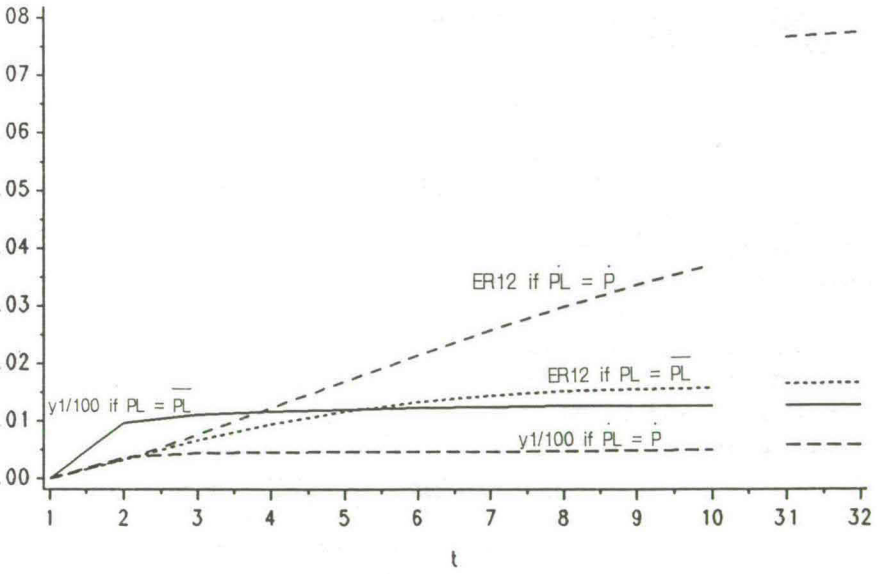

Diagram 7.3

Diagram 7.3 pertains to the case where the government(s) choose(s) to finance extra deficits by increasing the money supply.

The fiscal policy stimulates output and output prices. The home currency depreciates as a result of a deteriorating trade balance (extra import demand -due to the impulse- stimulated by the higher prices of county one's products). With indexation, wages rise immediately which mitigates the output expansion. In the subsequent periods the depreciation continues: the increased employment increases spending (inclusive the demand

for imports). With indexation the depreciation is much larger as a result of the wage-price spiral mentioned above.
The above conclusion on bond financed fiscal policy is upheld with monetary financing.
Moreover, comparison of the present diagram with the previous one shows that with sticky nominal wages the exchange rate and output are lower in the longer run than they are with bond financing (where the depreciation between periods 30 and 31 is steeper). As a preliminary conclusion, bond financing is more effective in the long run than money financing if nominal wages are fixed.[44]

The developments following an expansionary fiscal policy if the extra deficit is financed by an increase in the tax rate on profits and interest receipts are very similar to those found under bond financing. The former implies a lower rate of growth in financial wealth (net interest receipts -partially added to wealth- decline) and thus a smaller demand for bonds, whereas the latter implies an increased supply of bonds. In both cases the price of bonds falls (interest rate rises).
A difference is found in the short run (t=2), see Diagram 7.4. As only about 50% of wealth is invested in bonds, a fall in wealth only goes for about 50% at the expense of bond demand. As a result, the capital account surplus is now lower and, given the shortage on the trade account, the appreciation (found with bond financing) is replaced by a smaller appreciation if wages are fixed in real terms and by a small depreciation if they are fixed nominally.[45] As with bond financing, the appreciation in the former case cannot prevent the price index (and thus wages if they are indexed) from rising.
In the longer run the currency depreciates as a result of a deficit on the service account. If nominal wages are rigid, this depreciation is relatively mild: as employment grows (with output), the increase in the profit tax rate can be partly reversed during the adjustment process. But with indexation of wages, the rise in (also indexed) transfer payments necessitates further increases in that rate of taxation and thus, in the longer run, higher deficits in the debt service account. The exchange rate even exceeds the one with bond financing.

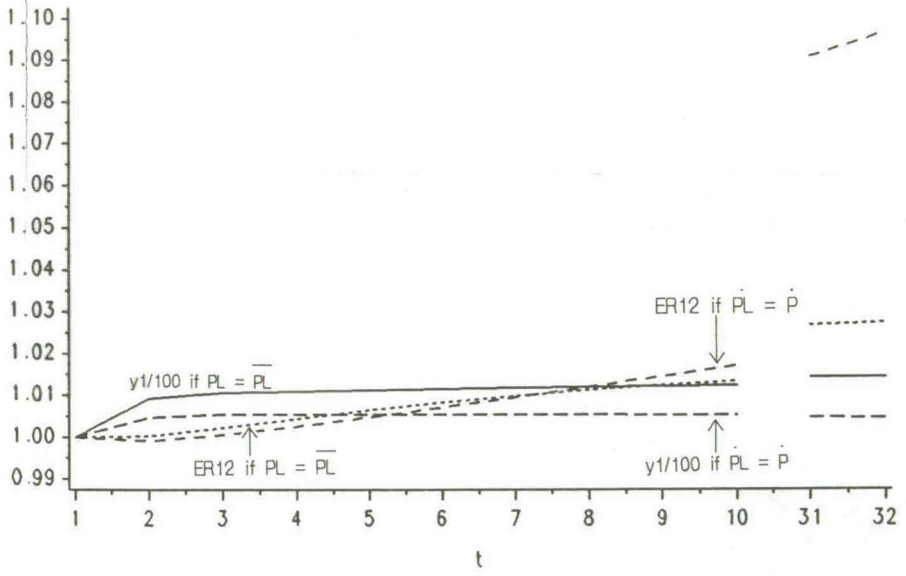

Diagram 7.4

If fiscal policy is financed by higher taxes on profits and interest proceeds, the conclusion drawn on the basis of bond financing also holds.

The exception to this rule is found if labour taxes are increased to finance the fiscal policy.
If Sachs' assumption that governments and households have equal marginal propensities to import is still held here, in the SIER model an expansionary fiscal policy will always be ineffective (see Diagram 7.5), as it merely implies a switch between private and public consumption.
If we replace this assumption by the one originally applied in the SIER model (governments do not import at all), Diagram 7.6 is obtained.[46]
The switch to home production creates a rise both in home output and in home output prices. Moreover, a trade balance surplus results, causing the

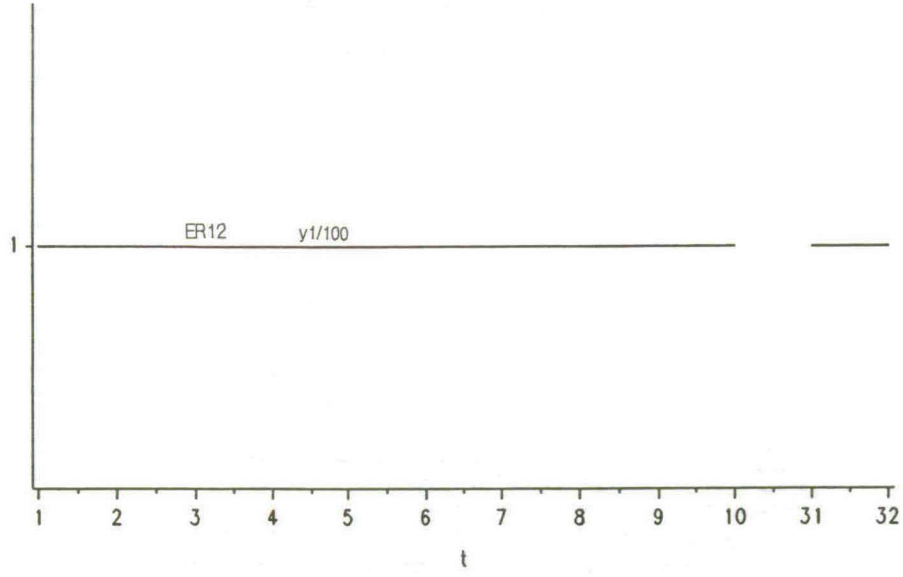

Diagram 7.5

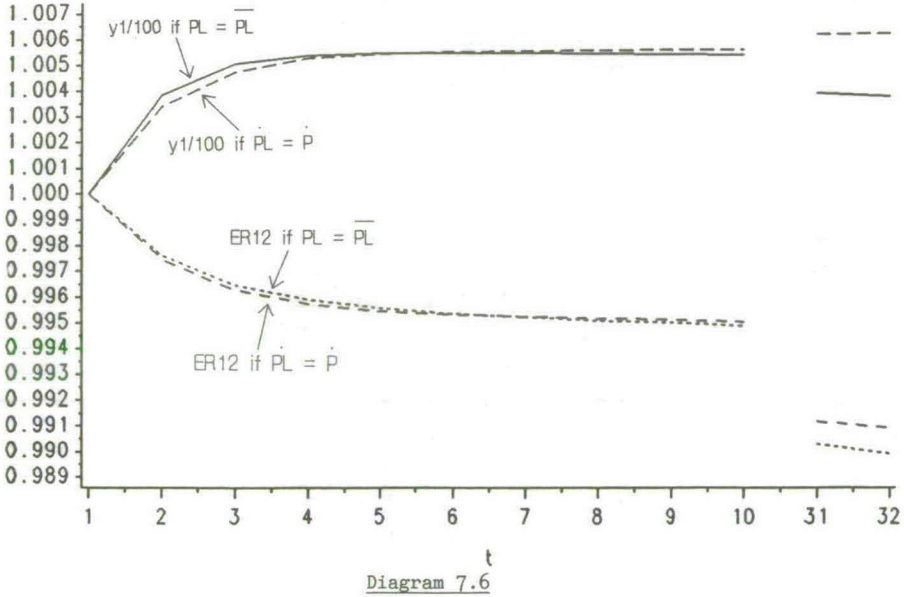

Diagram 7.6

currency to appreciate. Notwithstanding this appreciation and the fall in output prices in the outside world (lower demand for their products), the overall price level in the home country rises (contrary to Sachs).
If wages are fixed nominally, the rise in private consumer spending in the subsequent periods lowers the appreciations. The continuous appreciations lower exports and in a certain period (period 7) output and thus employment and spending decline, giving rise to further appreciations, harming output, etc. Although not resulting immediately, this is the mechanism causing the inefficacy of fiscal policy in the basic M-F model.
With rigid real wages, the immediate rise in the overall price level (see above) causes its wage level to rise. When compared to sticky wages, the supply curve shifts to the left (upward), reducing output and employment. Together with higher transfer payments, this increases the government deficit, necessitating a steeper rise in taxes and thus a slightly higher appreciation. Appreciations are found in all periods, although they are gradually reduced by the price-wage spiral. In period 7 they force the wage level below its initial value. Here the mechanism comes into effect, on the basis of which Sachs concluded that indexation would make fiscal policy more effective. But he expects it to work in the short run, whereas in our model it operates in the intermediate run.

Conclusions

With regard to fiscal policy we can conclude that in our framework:
- the link 'appreciation-wage reduction' is only found if the fiscal policy is labour tax financed provided the government's marginal propensity to import is lower than the one of the public;[47] moreover, also in that case it does not operate immediately, leaving fiscal policy more effective in the short run if indexation is absent.
- in none of the cases was the fiscal policy found ineffective.
- apart from labour tax financing, in all periods the efficacy of fiscal policy was harmed by indexation.
- in the short run fiscal policy is not ineffective and indexation makes it less effective (contrary to Sachs). Provided the fiscal expansion is not labour tax financed, indexation does make it less effective in the

long(er) run (in line with Sachs), but not ineffective or counterproductive (contrary to Sachs). If it is labour tax financed, in the long(er) run indexation makes the policy more effective (contrary to Sachs).

- (preliminary,) fiscal policy is more effective in the long run if it is bond financed than if it is money financed, provided nominal wages are fixed.

As stated, more conclusions were drawn in the project on which this section is based, especially on effects on the outside world. Moreover, it would be interesting to analyse the efficacy of monetary and fiscal policy with different assumptions on wage behaviour in the respective countries. Attempts in this direction are found in Branson and Rotemberg (same reference) and Van der Ploeg [48] and are also possible using the SIER framework.

Section 3 Assuming alternative behaviours

This section contains:
Section 3A on intertemporal substitution and the efficacy of commercial policy, and
Section 3B illustrating some implications of the asymmetric investment behaviour developed in Chapter 6.

Section 3A Intertemporal substitution and the efficacy of commercial policy

Introduction

If my name were Sweder van Wijnbergen, I would have asked myself the following question: what are the implications of commercial policy (i.e. import tariff policy) for output and employment and the current account surplus if one starts from the idea that consumers shift expenditures between today and tomorrow, buying products when they are cheap? Moreover, having read the previous section, I would have analysed this problem under alternative wage systems, assuming that the outcomes would depend on the

way wages are set.[49] The general notion would be straightforward: import tariffs are likely to raise the consumer price level,[50] and if wages are indexed, the wage level will rise and the product wage can increase, reducing output and employment.
This section (3A) illustrates that by inserting some of Van Wijnbergen's assumptions into the SIER framework many of his more important conclusions[51] are obtained relatively easily.[52] As a consequence, I would have tried to answer this question by using that SIER framework.

Van Wijnbergen's major conclusions that we will focus upon can be summarized as follows.

1. The effects of tariffs on the current account and employment (output) depend on the assumptions regarding wage and savings behaviour.
2. As long as real wages clear the labour market and capital is fixed,[53] a permanent increase in tariffs leaves the current account unaffected. Van Wijnbergen explains this as follows: since the income effects caused by tariff induced terms of trade changes are equal over time, and "a tariff changes relative prices within the period in which it is levied, but a permanent tariff does that both today and tomorrow, leaving the relative price of consumption today in terms of consumption tomorrow (.....) unaffected, ... savings will not change, which explains the absence of a current account impact" (p. 698).
A temporary tariff, however, leads to a current account surplus. Expenditures are delayed to the next period due to the relative price increase of consumption today in terms of consumption tomorrow. Moreover, in the impulse period a stronger terms of trade income effect is observed than in the future (only partially spent in the impulse period).

3. If wages are immediately indexed,[54] an increase in tariffs leads to a decrease in output and employment. The reason is straightforward. An increase in tariffs induces the consumer price index and therefore nominal wages to go up. The latter forces real product wages up, due to the fact that product prices do not rise as much as consumer prices and therefore

wages. This implies that an unanticipated tariff leads to initial unemployment via the resulting upward pressure on the real domestic product wage.
As a result, indexation may worsen the above impacts on the current account (lower exports). On the other hand, positive price movements may reverse this negative impact.

4. With flexible investments and labour market clearing wages, a permanent tariff leads to a decline in investments due to an increase in the costs of capital goods. Initially, the decrease in investments leads to a current account surplus. The cut in investments, however, reduces aggregate supply in period two, which in turn leads to higher prices in that period, forcing expenditures in period one up. The latter leads to a deterioration of the current account, which may offset the initial positive impact on this account.

Adjustments in the SIER model

The SIER model is changed in the following respects.
1. In 'iebtest' possibilities are created to introduce a temporary import tariff (alternatively, the import duty is permanent) and/or fixed investments.
2. Tariff revenues are redistributed to consumers to make tariffs a purely expenditure switching device. Private expenditures are no longer determined by tariff revenues.[55]
3. For the same reason as in the previous section, household income earned in period t-1 is disposable in period t.[56]
4. Intertemporal substitution is introduced in consumer spending/savings. Dissavings, denoted DISSV, are determined by the expected rate of inflation on the one hand, and net income on the other and equal

$$(7.1)\quad DISSV_t = (YL_{t-1} + TRF_{t-1} - BL_t) \times \left[\frac{P^e_{t+1} - P_t}{P_t} \right]$$

Dissavings will go up, if consumers expect inflation. The consumer price index expected for one period ahead is determined as a weighted average of

expected prices of home produced goods and tariff inclusive import prices. If a tariff is known to be temporary, future tariffs are zero, and the expected consumer price index will cet par. be lower than the present consumer price index. In that case DISSV is negative.

We assume that dissavings in period t will lead to savings in t+1. If so, the latter period will be characterized by lower expenditures relative to trend and therefore lower prices due to lower aggregate nominal demand (ceteris paribus). As described in Chapter 2, expected demand in period t+1 is calculated using an extrapolation of present demand. To extrapolate on the basis of the correct level of expenditures, and thus to get the correct expected product price for one period ahead, the actual aggregate nominal demand in t is adjusted for (dis)savings due to intertemporal substitution, resulting in $YNET_t$. Expected demand for t+1 equals a weighted average of present and past YNET corrected for current dissavings. Division by expected output results in expected output prices.

$$(7.2)\quad Py^{e}_{t+1} = \frac{(\ YNET^{e}_{t+1} - DISSV_t)}{y^{e}_{s,t+1}}$$

where

$$(7.3)\quad YNET_t = Y_t - DISSV_t$$

We assume fixed exchange rates, substitution between factors of production, and no monetary sector; if investments are flexible, they are assumed to equal an exogenous part[57] of the gap between the cost minimizing and the 'actual' stock of capital (see Chapter 6). In that case Van Wijnbergen assumes that investments vary along with the value of future output produced with capital over the costs of capital goods. He assumes that import tariffs are also levied on imported investment goods. Consequently, if investment goods are made more expensive via an import tariff ceteris paribus investment falls initially.

Another important difference between our model and the one used by Van Wijnbergen is that the latter assumes rational expectations, whereas in the SIER model expectations are partly extrapolative. Moreover, whereas Van Wijnbergen assumes wages in the second period (his last period) to be

set at such a level that unemployment vanishes, we will start from the assumption that wage behaviour is consistent in all periods.
In the complete research project four different assumptions on wage behaviour are made: rigid product wages (wages adapt to output prices)[58], immediate indexation of wages (wages adapt to consumer prices), lagged indexation of wages and rigid nominal wages.[59] All four alternative wage equations are combined with fixed and with a variable capital stock.
As Van Wijnbergen only distinguishes the first two options[60], below we will focus on the conclusions derived with those two wage assumptions.

Conclusions

As in the previous section the results of the simulations are summarized in diagrams. In principle, each diagram contains four lines, depicting output and the trade balance with a permanent vs. a temporary tariff, respectively.[61]
Comparison of Diagrams 7.7 to 7.9 immediately shows that Van Wijnbergen's first conclusion holds: output and current account (here trade balance) developments crucially depend on the nature of tariffs as well as on the way wages are set.

Diagram 7.7 relates to tariff increases with rigid product wages and a fixed stock of capital. As output is fixed, the lines depicting output development under both regimes (temporary vs. permanent tariffs) coincide and are at a zero level in all periods.
A tariff raises home output prices. If the tariff is permanent, a further price rise is anticipated, which leads to dissavings. But this effect is overruled by the fact that the higher wages (caused by higher output prices) are not spent before the next period.[62] So, real spending opportunities fall and a surplus on the current account results. As such, this contradicts Van Wijnbergen, but the effect can be attributed to lagged spending opportunities. More important, if the tariff is temporary, the initial surplus is higher, due to increased savings: as people expect a reduction in tariffs, they also anticipate a reduction in the price level and decide to save today and spend extra tomorrow. This is in line with the argument put forward by Van Wijnbergen.

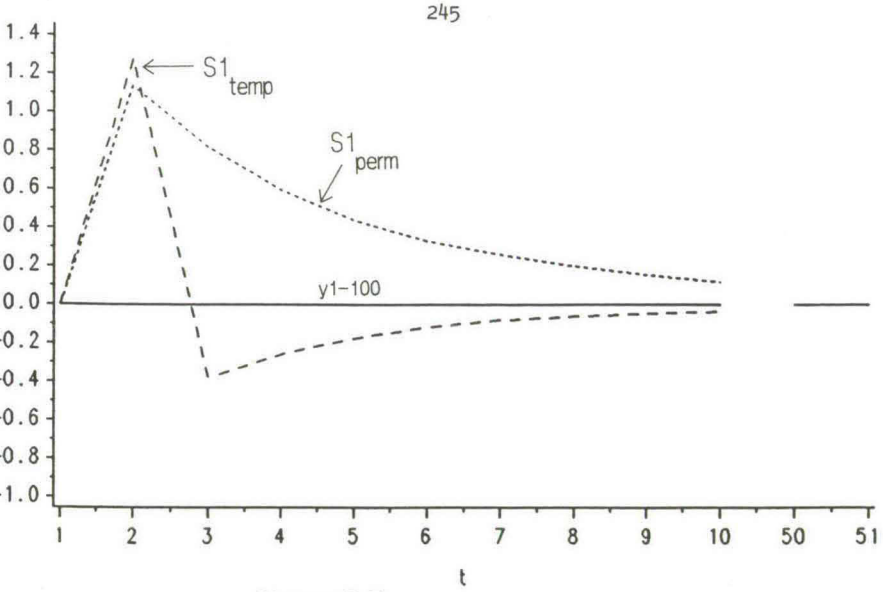

Diagram 7.7

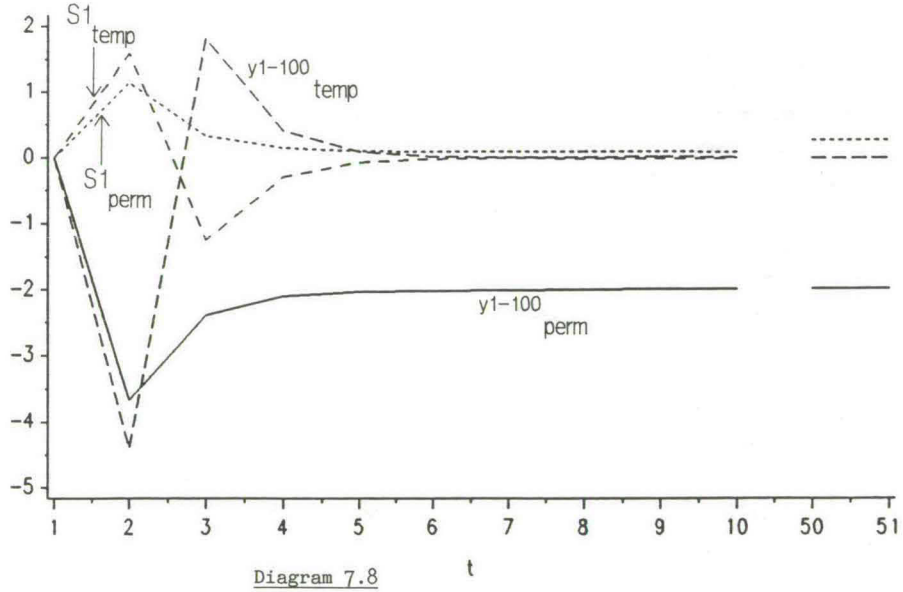

Diagram 7.8

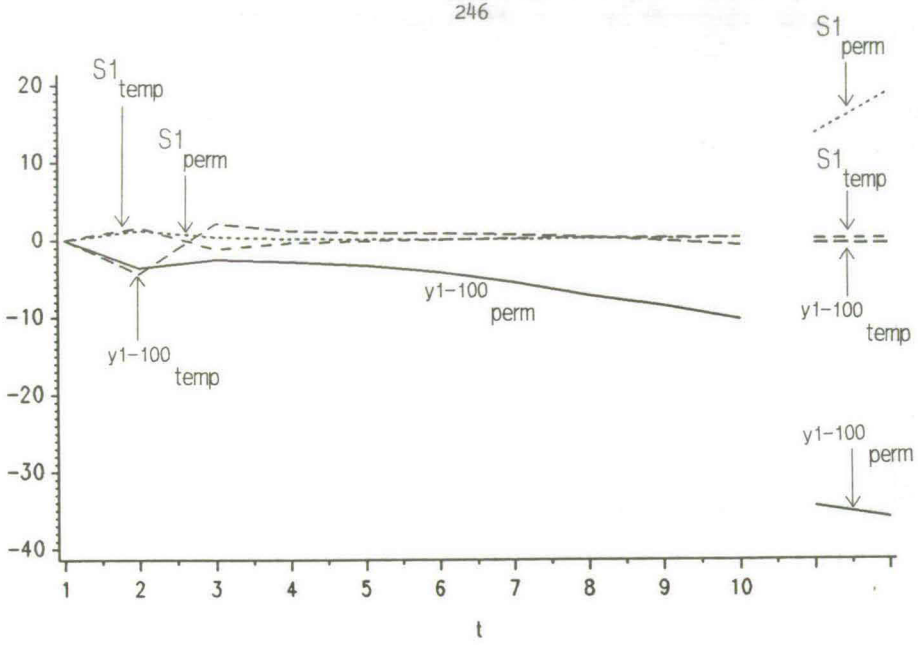

Diagram 7.9

With a temporary tariff, the surplus is reduced faster. Of course, this is due to the removal of the tariff as such, but also to the dissavings compensating the initial savings.
Whereas the effect of a temporary tariff slowly "leaks away", the permanent import duty results in a long run decline in the import/consumption ratio (with imports constant and home consumption higher). In both cases the trade balance returns to zero.[63]

The developments in trade balance and production reproduced in Diagram 7.8 relate to the situation where real wages are fixed (i.e., if nominal wages increase with the consumer price index) and capital does not fluctuate. Clearly, in both cases output[64] is harmed. Wages rise faster than output prices which results in an increase in the product wage. This finding is in compliance with Van Wijnbergen. If the tariff is temporary, in the long run this effect vanishes.
In the short run the trade balance is positively influenced although real exports fall, due to higher output prices and reduced imports. Although

the wage rate is adjusted to the higher price level, spending out of this increased (nominal) income is delayed (see above). A surplus on the current account is the result. But whereas with a permanent tariff dissavings due to intertemporal substitution mitigate this effect, with a temporary tariff the expected tariff removal leads to extra savings, furthering the initial trade balance improvement. Again, this is in line with Van Wijnbergen.

With indexation a temporary import duty results in a higher initial trade balance surplus than if product wages are rigid. The fall in real output observed here on the one hand increases present output price rises and on the other hand attenuates the expected growth in nominal demand and thus the expected inflation. As a result, the (positive) difference between present prices and future prices is higher with indexation, furthering present savings and thus the trade balance surplus.

In the subsequent period these savings are dissaved. Together with increased household spending opportunities (previously grown wages are spent now) and the reversal of the tariff (lowering the consumer price index and thus wages), this explains the remarkable (but temporary) recovery in output if the tariff was temporary. The recovery is only partial if the tariff is permanent. Product wages have permanently increased there because of the import tariff.[65]

If capital is flexible and product wages are rigid, the optimal capital stock does not deviate from its starting value: $P_L^{.e} = P_y^{.e}$ and $P_k^{.e} = \delta P_y^{.e}$, so the expected relative factor prices are constant; moreover, as with rigid product wages output is fixed, the same holds for expected output, the second determinant of the cost minimizing stock of capital. Hence, Diagram 7.7 also pertains to the case of flexible capital and rigid product wages.

If wages are indexed to the consumer price level and capital is flexible, the results can be summarized as in Diagram 7.9.

Initially, the developments equal those in the previous diagram, as in the impulse period only the decisions to (dis)invest are taken.

With a permanent tariff the expected consumer price index is relatively high as are expected wages. This forces expected output down which leads to divestments. Hence, if compared to the previous diagram, in period 3 demand for investment purposes declines (see Van Wijnbergen's conclusion

considering a permanent tariff assuming rigid product wages).[66] The capacity effect of these investments will after some time decrease supply and cause an increase in output prices. A larger discrepancy between expected labour costs and output prices results, reducing expected supply, etcetera. The system explodes after 26 periods.[67] Output continuously falls, the trade balance continuously grows (price effects).
If the tariff is temporary, however, expected future consumer prices are lower (the tariff is expected to be removed), leading to a more modest anticipated wage increase. Expected wages rise less than expected output prices. An increase in output is foreseen, leading to an increase in the optimal stock of capital. Investments rise initially. But after the tariff removal, this is reversed. In the (true) long run all effects vanish.

We conclude that the above adjustments in the SIER model suffice to obtain the major conclusions drawn by Van Wijnbergen relatively easily. Moreover, although they were not discussed here, the same simulations reveal the effects of the tariff policy on the outside world. Furthermore, with no extra effort a monetary sector could be included (with or without international capital mobility), and an alternative wage behaviour, production function, investment function and/or exchange rate system could be chosen. The effects of retaliation (tariff war, customs union, etcetera) could be studied easily. All of these factors would complicate a traditional analysis (as the one by Van Wijnbergen) considerably.
As in the previous section, an important difficulty, however, still lies in calculating the real long run outcomes if full and immediate indexation of wages is assumed.

Section 3B Asymmetrical investment behaviour

Introduction

In Chapter 6, section 1, an alternative investment function was presented, labelled 'the asymmetrical investment function'(equation 6.8). In the present section we will discuss some of the consequences for the model's behaviour if the game leader would choose this option.

First, under the heading 'pattern of development' we will illustrate that assumption of this investment behaviour leads to a continuous cyclical development in endogenous key variables in the economy, as opposed to a return to a (possibly new) trend value if the investment function of Chapter 6[68] is assumed. We will argue that this cyclical pattern is explained by the fact that a smaller gap[69] is now filled to a larger extent by net investments.

Secondly, under the heading 'asymmetry' the asymmetric properties of this investment behaviour will be illustrated as well as explained. Moreover, in the same part consequences for some of the trend values, i.e., average long run values, will be discussed.

To keep the discussion as simple as possible, throughout this subsection we will assume a model without (explicit) monetary sector and discuss (mainly world-wide) demand impulses only.

Pattern of development

Diagram 7.10 displays:

- the development in country one's firm output after a 5% world-wide government expenditure increase if the asymmetric investment function applies (let us call this 'combination 1')
- its counterpart following a 10% world-wide government expenditure increase with Chapter six' symmetric investment behaviour (let us call this 'combination 2').[70]

Whereas in the latter situation the economy rather quickly returns to a new stationary situation, the former investment behaviour leads to a cyclical development in all periods.

The difference between the two is explained by a feature embodied in equation (6.8): if the gap is small, a larger proportion of the gap is filled, (and vice versa). The economic interpretation here is as follows. Compare two situations, A and B with about equal initial stocks of capital. In A, a 'gap' of 10 machines exists, in B a 'gap' of 5 machines. The purchase of the 6th machine in case A causes more disutility than the purchase of the third machine in B. Ceteris paribus, in B (with a small gap) a higher proportion of the gap will be filled by planned investments than in A. In

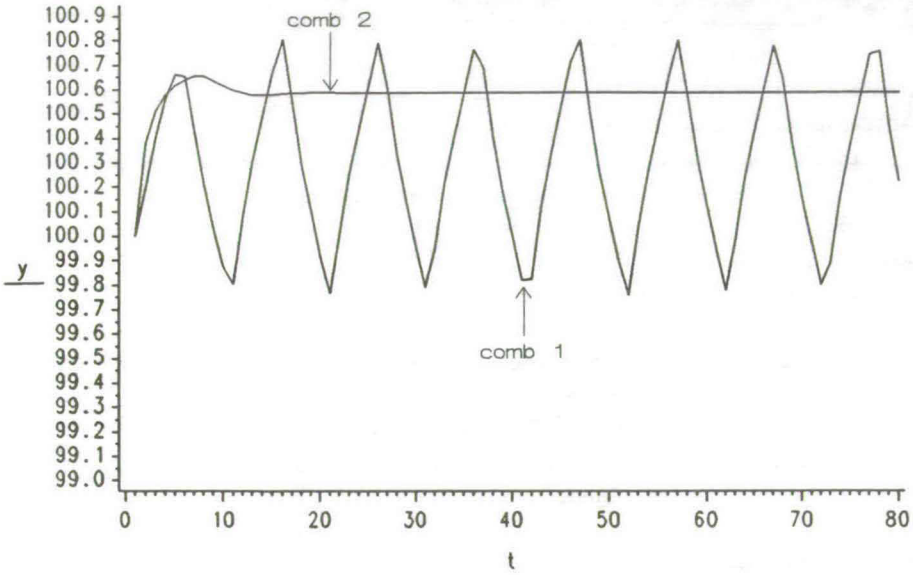

Diagram 7.10

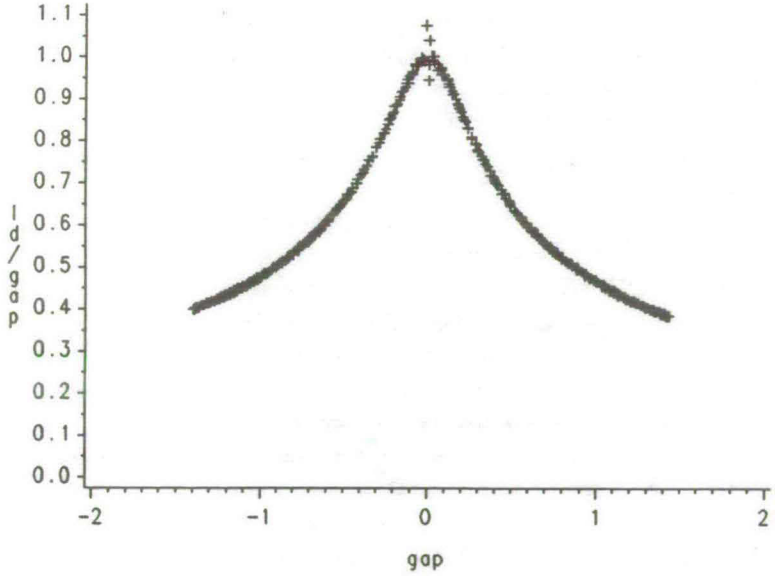

Diagram 7.11

the extreme, if 'gap' approaches zero, i_D approaches 1. This feature is illustrated in Diagram 7.11, where for all periods between 200 and 750 (end of calculation period) the combinations of the ratio i_D/gap and gap are depicted.[71] In the symmetric investment function, i_D moves proportionately with gap by definition. In other words, as k follows k^*, and with a delay approaches k^* in both cases (see below), (6.8) implies that when the gap narrows, the speed with which the remaining gap is filled increases in relative terms, whereas in the symmetric case this speed is constant.

This different behaviour implies that application of (6.8) leads to a larger 'overshooting' by k of k^*, which is illustrated in Diagram 7.12.

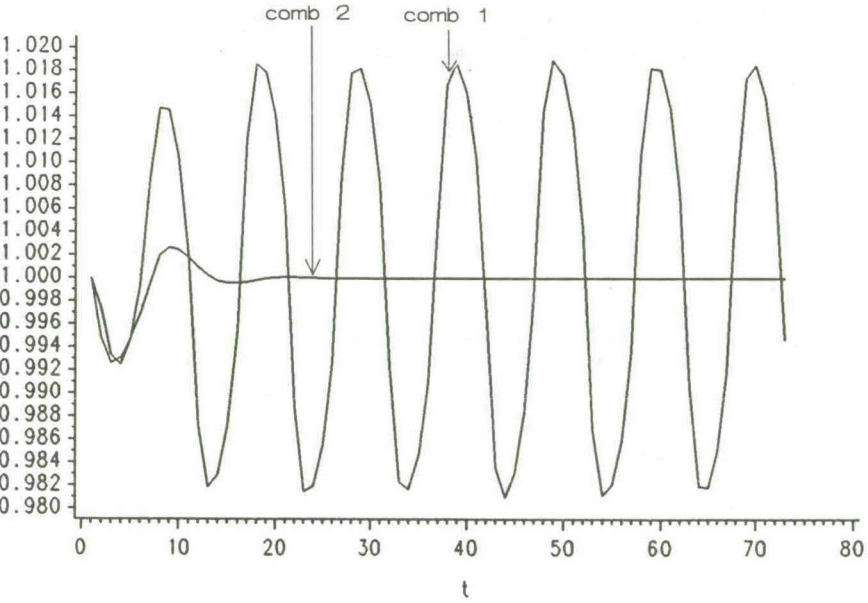

Diagram 7.12

This diagram displays the ratio k/k^* for combination 1 as well as for combination 2. If the ratio exceeds 1, k overshoots k^*; if it is lower than 1, k undershoots k^*.

In the periods immediately following the impulse, k^* rises, but k is still unaffected in both cases.[72] This results in initial undershooting. After a delay, k reacts and overshoots k^* in both cases. But combination 1 leads to a larger overshooting than 2.

A higher degree of overshooting has as a consequence that the remaining gap is now more negative. k shrinks in order to adjust to the low k^*. By the same token, if investments follow (6.8), k undershoots k^* to a relatively large extent, etc.

Where the gap between actual and cost minimizing capital stock vanishes with the symmetric investment function, it continuously returns if (6.8) applies. This feature is also displayed by Diagram 7.13 where the values over the business cycle of 'gap' and i_D are depicted, following a worldwide 10% expansion of government expenditures assuming (6.8). This picture also shows that a higher gap leads to more investments and vice versa (see Chapter 6).

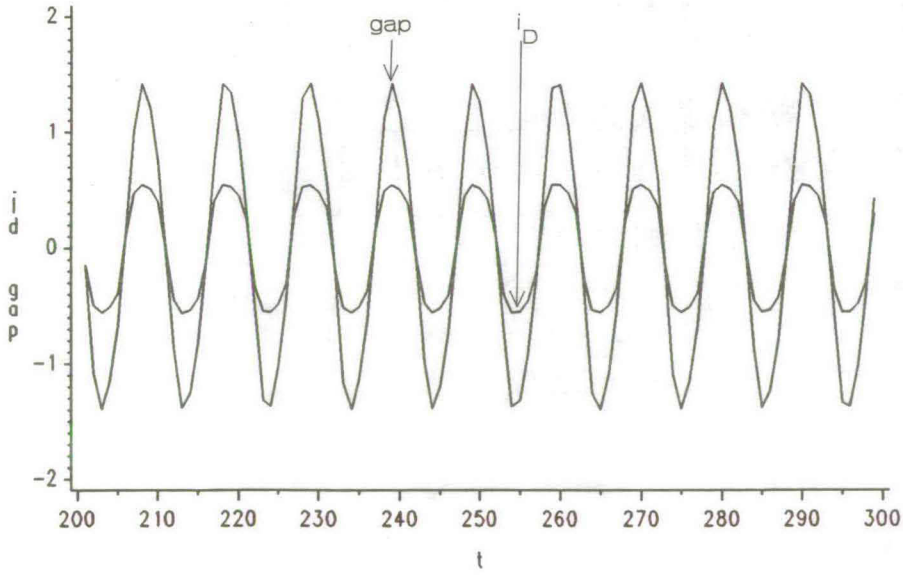

Diagram 7.13

Asymmetry

Now we turn to the asymmetric properties of equation (6.8).[73]
Diagram 7.14 gives the ('scaled') values of capital stock, output prices, profits and 'gap' over in the business cycle following a world-wide increase in government expenditures of 10%.

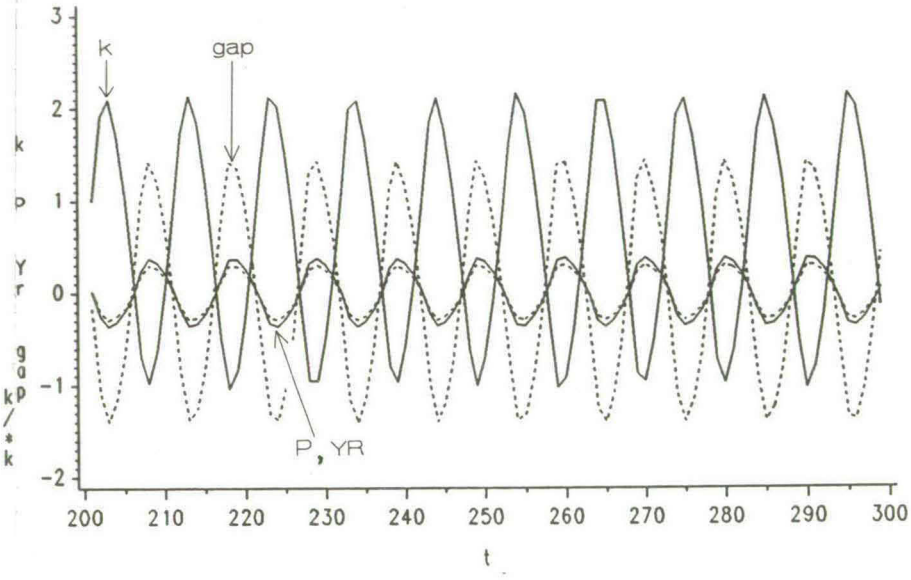

Diagram 7.14

If the capital stock is large, supply of products is relatively high, and output prices are low. With rigid nominal wages, the latter implies that losses are incurred. Hence, a large capital stock coincides with losses. By the same token, a small capital stock coincides with profits. At the same time (see above), if k is high, as a rule 'gap' is negative (also displayed in the same diagram).
Equation (6.8) implies that entrepreneurs are more eager to get a cost reduction if losses (cq. modest profits) are incurred than if profits are high.

As a high value of k coincides with losses and a negative gap (see above), this gap will be filled (with disinvestments) relatively fast. But if k is small (i.e., profits are relatively high), the positive gap (calling for net investments) will be filled relatively slowly: entrepreneurs are less anxious for a cost reduction.

As a result, a high k is reduced more quickly than a low k is raised. On balance, therefore, the average value of the capital stock will shrink relative to the one of production. And given the shape of the production function, the opposite holds for employment.

Examples are found in Table 7.5 where under different assumptions the trend values (i.e., the average values obtained as soon as a 'steady cycle' is reached) for some key variables are shown following a government expenditure increase of 10%.[74]

In the first column, as a point of reference, the long run values are reproduced that were found in Chapter 6 where the symmetric investment function was applied. In the other columns, equation (6.8) is assumed.

The second column shows that in trend values

- the capital stock is lower than the one that would result in minimization of production costs ($k < k^*$); (in Chapter 6: $k = k^*$)
- the capital intensity of the production process is lower than its initial level, the labour intensity is higher; (in Chapter 6: both return to 1)
- (whereas they returned to 1 in Chapter 6,) output prices rise (as a result of a relatively low stock of capital) to such an extent that the initial income distribution is restored (as in Chapter 6)

As the explanations for the conclusions given above are independent of the direction of the impulse, the same conclusions are found if governments contract their expenditures (column 3). With an expansionary impulse, employment grows faster than output (with a contractionary impulse, it falls less), but output is lower than found in Chapter 6. This is caused by the less than proportionate increase (resp. more than proportionate fall) in the capital stock.

If only country 1 expands (column 4), in the home country similar effects are found. The more interesting effects are, however, found abroad.

1		2		3		4			
Gi = 10 id = 0.25 * gap		Gi = 10 id = f(U)		Gi = -10 id = f(U)		G1 = 10% id = f(U)			
Y1	100.590	Y1	100.580	Y1	99.3999	Y1	100.559	Y2	99.997
CO1	60.0566	CO1	60.0532	CO1	59.9396	CO1	60.0512	CO2	59.9971
I1	20.1179	I1	20.1125	I1	19.8766	I1	20.1086	I2	19.9958
EX1	16.0151	EX1	16.0142	EX1	15.9839	EX1	15.9993	EX2	16.0040
M1	16.0151	M1	16.0142	M1	15.9839	M1	16.0136	M2	15.9992
						S1 N	-.01437	S2 N	0.00479
PY1	1.00000	PY1	1.00006	PY1	1.00006	PY1	1.00006	PY2	1.00006
PL1	0.80000	PL1	0.80000	PL1	0.80000	PL1	0.80000	PL2	0.80000
WB1	0.60800	WB1	0.60797	WB1	0.60797	WB1	0.60797	WB2	0.60797
LM1	100.590	LM1	100.586	LM1	99.4061	LM1	100.565	LM2	100.003
K1	100.590	K1	100.562	K1	99.3821	K1	100.542	K2	99.981
YL1 N	80.4717	YL1 N	80.4688	YL1 N	79.5249	YL1 N	80.4519	YL2 N	80.0026
YR1 N	-.00000	YR1 N	0.00382	YR1 N	0.00411	YR1 N	0.00378	YR2 N	0.00387
U1	2.51322	U1	2.51623	U1	3.45501	U1	2.53306	U2	2.97957
KOPT1	100.590	KOPT1	100.577	KOPT1	99.3980	KOPT1	100.557	KOPT2	99.994
YN1 E	100.590	YN1 E	100.588	YN1 E	99.4086	YN1 E	100.567	YN2 E	100.006
Y1 E	100.590	Y1 E	100.583	Y1 E	99.4023	Y1 E	100.562	Y2 E	100.000
PY1 E	1.00000	PY1 E	1.00006	PY1 E	1.00007	PY1 E	1.00006	PY2 E	1.00006
PK1 E	0.20000	PK1 E	0.20001	PK1 E	0.20001	PK1 E	0.20001	PK2 E	0.20001
PL1 E	0.80000	PL1 E	0.80000	PL1 E	0.80000	PL1 E	0.80000	PL2 E	0.80000
PYEt+1	1.00000	PYEt+1	1.00006	PYEt+1	1.00006	PYEt+1	1.00006	PYEt+1	1.00006

5		6			
Gi = 10% temp. id = f(U)		G1 = 10% temp. id = f(U)			
Y1	99.990	Y1	99.990	Y2	99.990
CO1	59.9965	CO1	59.9965	CO2	59.9965
I1	19.9947	I1	19.9947	I2	19.9948
EX1	15.9991	EX1	15.9991	EX2	15.9991
M1	15.9990	M1	15.9991	M2	15.9990
		S1 N	0.00000	S2 N	-.00000
PY1	1.00006	PY1	1.00006	PY2	1.00006
PL1	0.80000	PL1	0.80000	PL2	0.80000
WB1	0.60797	WB1	0.60797	WB2	0.60797
LM1	99.996	LM1	99.996	LM2	99.996
K1	99.974	K1	99.974	K2	99.974
YL1 N	79.9969	YL1 N	79.9969	YL2 N	79.9969
YR1 N	0.00388	YR1 N	0.00390	YR2 N	0.00383
U1	2.98521	U1	2.98523	U2	2.98513
KOPT1	99.988	KOPT1	99.988	KOPT2	99.988
YN1 E	100.000	YN1 E	99.999	YN2 E	99.999
Y1 E	99.993	Y1 E	99.993	Y2 E	99.993
PY1 E	1.00006	PY1 E	1.00006	PY2 E	1.00006
PK1 E	0.20001	PK1 E	0.20001	PK2 E	0.20001
PL1 E	0.80000	PL1 E	0.80000	PL2 E	0.80000
PYEt+1	1.00006	PYEt+1	1.00005	PYEt+1	1.00006

Table 7.5

Foreign countries experience two impulses: a positive influence (positive demand impulse, see exports), and a negative one caused by the existence of a business cycle which reduces the average stock of capital and as such reduces supply (negative supply impulse). On balance, output falls, the capital stock falls more (facilitating a rise in employment), and (both output and consumer) prices rise. As these results are the outcome of two opposite forces, their on balance effect might as well be positive. We conclude, however, that under these circumstances a fiscal expansion cannot simply be labelled 'sustaining' anymore.

In the previous chapters, a temporary increase in demand would have had no long run effects. But with the asymmetric investment equation such a policy does influence the trend values. The wave produced by the impulses functions as a negative supply shock: the average stock of capital falls and output and employment fall with it. See columns 5 and 6, both reporting the trend values following a 10% increase in government expenditures in period 2 and an opposite impulse in period 3. In column 5 all countries act in this respect, in column 6 only country 1 intervenes. Apart from some rounding errors, the average long run results in all countries are equal as the demand effect of the impulse is cancelled out. The supply effect -a shrinking capital stock as a result of the created business cycle- remains.

The simulations studied so far lead us to the preliminary conclusion that if an asymmetric investment function applies and a government wants to avoid negative supply shocks, it should not function as a 'shock-maker' but as a 'shock-breaker'.

NOTES (Chapter 7)

1 That is, a country will act and only act if the intervention is beneficial to its employment and production. If these two aims conflict, see below.

2 We simplify matters further here by excluding the possibility of "hypothetical international compensation", by considering only one type of policy at the same time, as opposed to (possibly internationally differing) combinations of policies and by treating "the other countries" as one entity: they either act in common or they do not act at all. Moreover, all interventions are based on the internationally equal starting positions described in the preceeding chapters. These simplifications as well as the assumption of a simple production and employment-goal, reflect the fact that this section serves only as an example for the research possibilities of the game. Of course, the conclusions below only hold given the validity of the assumptions.

3 In the present context, assuming equal countries in equal starting positions considering equal (or zero) policy interventions, "harmonization" equals "unification".

4 If the international spillover effects are higher and a unilateral action leads to a positive gain for the intervening country itself, an interesting problem results : which country is going to act 'first'?

5 These tables are not included in the separate 'table bundle', but are found at the end of this section.

6 In the remainder of this section we will not repeat that under these circumstances the effects of a unilateral action under flexible exchange rates are identical for the home country to the ones with a multilateral action, and are zero for the outside world.

7 Although not tested for all four tables, an analogous conclusion is probably valid for lagged vs. non-lagged reaction of consumers to changes in relative international prices.

8 In Table 7.1 and the ones to follow in this section, the names of the original tables of Chapters 3 to 6 are given from which the figures concerned are taken. This way we can refer to a section in the present overview by giving the name of that (original) table. If the figures in Table 7.1 are calculated separately, such is indicated.

9 Of course, it is also neutral in cases where insulation applies (flexible exchange rates, no ICM).

10 An exception here is the case of a vertical supply curve with substitution (Chapter 5), indicating the absence of unemployment, where in all cases the fiscal policy is equally (in)effective.

11 Remember that with ICM the table only gives values for period 200. The true long run position is not clear.

12 This conclusion can be verified by summation of the growth in production cq. employment in all countries in the period concerned, bearing in mind that countries 3 and 4 experience the same developments as country 2.

13 Or rather, accomodation of the transaction demand for money.

14 Although it may depend on the speed of consumer reaction and the time horizon (see Table 3a.3).

15 J. Frenkel and M. Mussa, 'Monetary and Fiscal Policies in an Open Economy', American Economic Review, 71, May 1981, pp. 253-258.

16 R. Caves and R. Jones, 'World Trade and Payments', Little, Brown and Co., Boston, 1985.

17 See the 'medicine' suggested in Chapter 4 to cure the long run instability if ICM is included.

18 With a wage rise we refer to an increase in all household incomes (inclusive non-private wages). If only private wages rise, in general, the impact on production and employment is worse.

19 That is, with substitutable production factors in t=2 and in t=4, with complementary factors of production in t=4.

20 If this conclusion could be reversed (in the sense that lower wages in one country would benefit its own performance and harm the outside world), wage policy could be labelled 'conflicting'. Since a world-wide wage decrease would then probably lead to zero effects (roughly speaking), international harmonization would be the likely result. Since Table 7.2 does not report on such a wage decline, these conclusions are premature. In general, a unilateral wage increase under fixed exchange rates harms a country's own economy, so it is unwise to pursue this policy in the first place. As a result, no country will increase its wage rate, and harmonization (of 'no intervention') is likely.

21 Both statements are valid under the condition that period 200 is indicative for the long run outcomes.

22 As noted in Chapter 4, if a monetary sector is included but no ICM, a tax reduction on interest proceeds is ineffective as the extra demand for bonds (higher wealth) equals the extra supply (higher government deficit).

23 Note that direct comparisons between columns are prohibited in parts a and b of Table 7.3 because in all columns 2 different impulses are carried out. As a consequence one cannot tell here whether a multilateral tax reduction would be preferable to a unilateral action or not. Questions on harmonization cannot be answered here.

24 If, with complementarity, account is taken of footnote 3 to the table.

25 If footnote 7 to the table is taken into account.

26 It will be remembered from Chapter 4 that different conclusions were drawn for a continuous monetary expansion.

27 W.Branson and J.Rotemberg, "International Adjustment with Wage Rigidity", European Economic Review, 13 (1980), 309-332.

28 Sachs, J., "Wages, Flexible Exchange Rates and Macroeconomic Policy", The Quarterly Journal of Economics, June 1980, 731-747.

29 This section as well as section 3A below is based largely on a previous joint research project with G.Frankena (presently Dutch Central Bank).

30 This assumption can conflict with the assumed fixed stock of capital: if capital is fixed (short run assumption), the distribution of income is not necessarily fixed. The assumption concerned is important in deriving the output function. Moreover, the short run assumption seems to conflict with Sachs' analysis of the long run impact of policies carried out on the basis of the same model (except for changes in wealth).

31 If the long run appreciation exceeds the one in the short run, with rational expectations money market equilibrium must imply a lower interest rate in the intervening country. With a given money supply, this equilibrium is achieved by a decrease in output.

32 Although in the above mentioned research project both alternative assumptions were applied in all cases, here we will only discuss the results obtained with Sachs' assumption, as the other results did not differ qualitatively unless otherwise indicated.

33 The necessary adjustments were made in the equations of F and P. The latter equation was changed to keep it the price level of final private absorption. B_L remains defined as current labour tax receipts.

34 We restrict ourselves to the situation here, where all countries act similarly in this respect.

35 The report on the full research project is available on request at cost price.

36 On the effects on the outside world, for example. Moreover, in future research the impact of capital accumulation will be investigated.

37 Since a few impulses regarding immediate and full indexation could not (yet) be calculated for over 31 periods, to get comparable results all impulses concerned were only computed for this limited number of periods. This implies that conclusions concerning the long run are provisional.

38 In each graph the dotted and the full line relate to fixed nominal wages and represent ER12 and $y_1/100$, respectively. The dashed lines relate to fixed real wages where the one consisting of small dashes indicates $y_1/100$ and the one composed of larger dashes refers to ER12.

39 The depreciation is not as large here as with fixed nominal wages as a consequence of the larger government deficit: with rising wages, salaries

of civil servants rise proportionately, leading to a higher rate of interest and thus a smaller deficit on the capital account.

40 Results of lagged indexation are not included in the graphs.

41 For the outside countries the opposite effects hold (not included in the graph).

42 One of the extra conclusions drawn in the full research project is that in the modified SIER model, with the exchange rate as the sole transmission mechanism, monetary policy becomes an expenditure switching policy. The specification of the wage equation determines the direction of the switch.

43 Therefore, in several ways an attempt was made to achieve a price drop as found by Sachs. The economy was made "small" by fixing import prices in the consumer price equation of the home country, the weights in the price equation were fixed, and perfect (as opposed to imperfect) capital mobility was introduced into the model. Neither way did prices fall following a bond financed fiscal expansion.

44 With indexation a conclusion in this respect is more dangerous if drawn on the basis of the figures presented here. In period 30 the exchange rate is higher than with bond financing, but in the latter case the currency appreciates initially and the rise in the exchange rate is steeper between periods 10 and 31 (as a result of the debt service account deficit). In other words, period 30 seems a worse indicator of the long run outcomes.

45 If wages are indexed, the government deficit rises faster due to higher transfer payments. Therefore, the necessary tax rate increase is higher in that case leading to a higher capital account surplus.

46 The scale of the vertical axis deviates substantially from the ones in the previous five diagrams.

47 The link was not found if the fiscal policy was half profit tax, half labour tax financed.

48 F. van der Ploeg, "International Interdependence and Policy Coordination in the OECD Economies", Inaugural Lecture, Network for Quantitative Economics, 1988.

49 See S. Van Wijnbergen: "Tariffs, Employment and the Current Account: Real Wage Resistance and the Macroeconomics of Protectionism". International Economic Review, vol. 28, no. 3, October 1987, pp. 691-706.

50 Because Van Wijnbergen assumes that the Metzler paradox does not obtain.

51 We will not concern ourselves here with Van Wijnbergen's conclusions regarding the small country-case, the non-specialization-case, and the possibility of using tariff revenues as wage subsidies.

52 As Section 2, Section 3A draws heavily on a research project carried out with G.Frankena. The full research report, her master's thesis, is available on request at cost price.

53 Obviously, output and employment are unaffected in this case.

54 And capital is still fixed.

55 The equation representing the budget deficit of the government, F, is adjusted correspondingly.

56 BL is defined as $TL_{t-1} * (YL_{t-1}+TRF_{t-1})$.

57 Here equal to 1/3.

58 Van Wijnbergen calls this 'labour market clearing wages'.

59 In the first three wage assumptions, expected cq. actual wages adapt to expected and actal prices, respectively.

60 Moreover, if capital varies, he only analyses the impact of a permanent import tariff.

61 For a permanent tariff the full line depicts (y1 - 100) and the dotted line refers to S1 N. For a temporary tariff (y1 - 100) is described by the line consisting of large dashes, whereas the line of smaller dashes relates to S1 N.

62 When spent, it reduces the surplus.

63 This way, Van Wijnbergen's conclusion that with rigid real product wages the current account does not change if a permanent tariff is introduced is reached here in the long run.

64 With capital fixed, developments in employment are fully determined by those in output.

65 Long run output also falls in the outside world because of an increase in 'real' product wages. Again this is caused by an increased consumer price level. But now, the latter stems from higher priced products imported out of 'our' country.

66 As investment goods are not imported in the SIER model, the effect on the trade balance is minimal and indirect. Although nominal exports increase (lower ouput price, higher volume), the trade balance in fact worsens when compared to Diagram 7.8 as a result of more imports due to expected price increases (caused by the anticipated decrease in the capital stock).

67 In Diagram 7.9 the 'longer run' effects of a permanent tariff relate to periods 25 and 26, whereas those of a temporary tariff concern periods 50 and 51.

68 With 'the investment function of Chapter 6' we refer to the symmetric function 'i_D = 0.25×gap' applied in the simulations of that chapter.

69 In absolute terms. 'Gap' was defined in Chapter 6 as the difference between the stock of capital that is expected to minimize production cost 2 years from now, and the stock of capital that will be obtained in that period if present net investment decisions are zero.

70 Applying the parameters chosen in equation (6.8), with equal impulses a certain rise in 'k*' leads to more planned investments. On the one hand, this causes a higher demand effect of investments and consequently a steeper rise in 'k*' (when compared to the symmetric investment equation). On the other hand, higher planned investments in t=2 lead to a higher expected capital stock in t=3 (expected for t=5), and thus to a higher 'k*', also. To get comparable developments in 'k*' (see below), the impulse percentages differ.

71 For very small values of gap, the ratio i_D/gap may exceed 1 due to rounding.

72 Due to the decision lag and the installation lag.

73 Application of (6.8) led to the cyclical pattern described above, as well as to a modest asymmetry. To get more pronounced asymmetric effects with modest impulses, (6.8) was slightly modified. Instead of measuring the utility of cost reductions directly, they were first related to current profits (plus C_2). For a given cost reduction this ratio falls if current profits are higher. The values for the parameters in (6.8) are $C_1 = 1000$, $C_2 = 2$, $C_3 = 0.5$
The asymmetry grew if 'conservatism' fell (i.e., if C_3 was lower), since the term producing the asymmetry (the first term) is relatively more important then. Asymmetry was more pronounced if impulses were larger. Other coefficients in (6.8) produced qualitatively the same results.

74 In Table 7.5, 'Gi' refers to a world-wide change in government expenditures and 'G1' indicates that government expenditures change in country 1 only.

Concluding Remarks

This dissertation presented a game first of all meant for didactic purposes. Several variants were discussed. As a check and to make the dissertation a guide for future game-leaders, several policies were simulated. The framework presented can also be used for future research purposes. The final chapter gave some illustrations in this respect.

As indicated in Chapter 1, however, the SIER Game is by no means finished. The models presented can and should be improved in various respects. The strict distinction between labour/consumers on the one hand and wealth owners plus entrepreneurs/(portfolio) investors on the other hand, the structure of the labour market (especially labour supply and the fact that governments can determine both the price of labour and the number of civil servants), the neutralization of the monetary consequences of trade balance disequilibria and the assumption of only one sector per country are a few examples of areas for improvement.

Moreover, the method used could be improved. The distinction between impulses and decision rules of economic subjects could be relieved, other expectation strutures could be assumed.

In all of these areas improvements and refinements could be made. The primary goal of the model should not be forgotten, however. Increasing the complexity of the model might endanger the usefulness of the Game as a learning tool.

List of symbols

(most symbols are listed under several headings)

general

Unless indicated otherwise, all symbols used indicate absolute magnitudes and refer to country i where i = 1,...,4 and to the present period, t. Dashes on top of symbols refer to exogenuity. They are predetermined by the game leader, just as coefficients in the model, or can be fixed by players. Dotted variables symbolize relative changes. The subscripts 't-1' or '-1' indicate a time lag of one period. Upper case symbols indicate values, lower case indicate real terms (volumes).

labour market

ℓ_s = total supply of labour

$\bar{\pi}$ = exogenous rate of growth in total labour supply

ℓ_m = number of people working in the private sector (including number of employers)

ℓ_g = number of people working in the government sector

ℓ_u = number of unemployed

ℓ_d = total demand for labour

u = unemployed as a percentage of total labour supply

P_L = wage in the market sector

φ_1, φ_2 degree to which the private wage rate rises immediately resp. lagged with inflation

ξ_1, ξ_2 degree to which the private wage rate rises immediately resp. lagged with labour productivity

λ_1, λ_2 0-1 parameter indicating the existence of an immediate resp.lagged influence of unemployment on the private wage rate

b_1, b_2 degree to which the private wage rate rises immediately resp. lagged if $u > \bar{u}$

$\bar{P}_L$ = autonomous relative change in the private wage rate defined as a percentage of the wage rate of the last period (policy instrument)

P = price of final private absorption (consumer price level)

P_{LCS} = salary per civil servant

$\bar{P}_{LCS}$ = autonomous relative change in the income of civil servants (policy instrument)

P_{LU} = income per unemployed

$\overline{P_{LU}}$ = autonomous relative change in the income of unemployed (policy instrument)

Y_L = total labour income earned in the private sector

Consumer spending

TRF ='transfers' = total payments to civil servants and unemployed

Y_L = total labour income earned in the private sector

B_L = labour tax revenue

$\bar{T}_L$ = tax rate on labour income

D = nominal net household income

w_B = net real consumer income

C = private consumption of goods produced in the home market

M = value of (total) imports before tariffs

M_{ij} = value of imports in i out of country j before import tariffs

$\bar{t}_{ij}$ = import tariff levied in i on imports out of j

BT_i = import tariff revenue for country i

ε = ratio between the amount of money spent on home produced goods and the amount spent on imports out of j

$P_{m_{ij}}$ = price of imports in i out of j in currency i after tariffs

ER_{ij} = exchange rate between i and j : the price of one unit of currency j in currency i

Physical capital/firms

Θ = life span of machines and period of reference for expectations

δ = percentage of depreciation per period

k = stock of physical capital available

k_v = stock of capital actually in use

k_{stat} = that stock of capital that results in a stationary situation

k^* = optimal stock of capital, i.e., the stock of capital that is expected to minimize production costs.

'gap' = difference between k^* and the stock of capital that would result if no net investments were planned (Chapter 6)

a = a marginal unit of investment (Chapter 6)

P_k = price of capital = $(r+\delta)P_y$

cap = y_{max} = maximum production capacity

i = volume of gross investments (in fixed capital)

i_D = net investment decisions

NP^e = net present value of expected gains (in money terms) from an expansion of the stock of capital by one unit

q = coefficient indicating the degree to which expected profits lead to net (dis)investments (= coefficient c536 of equation 4.2)

Y_R = gross firm profits

O_p = interest paid by firms

B = interest received by firms

ℓ^e_{mmax} = amount of labour expected to be available for the private sector two periods ahead

Government sector

P_{LCS} = salary per civil servant

ℓ_g = number of civil servants

$\bar{\ell}_g$ = autonomous relative increase in ℓ_g (policy instrument)

P_{LU} = income per unemployed

ℓ_u = number of unemployed

TRF = 'transfers' = total payments to civil servants and unemployed

g = material government expenditures in real terms

$\bar{g}$ = autonomous relative increase in g (policy instrument)

γ = coefficient indicating the amount of extra material government consumption (g) per extra civil servant

F = balance on the government account

O_g = government interest payments

B_R = revenue of taxes on profits and interest earnings

B_L = labour tax revenue

BT = import tariff revenue

$\bar{t}_{ij}$ = import tariff levied in i on imports out of j

$\bar{T}_L$ = tax rate on labour income

$\bar{T}_R$ = tax rate on profits and interest proceeds

Exports

x = volume of exports

Product market

P_{y_i} = price level of a product produced in i in currency i
Y = nominal demand for goods produced by firms in i
y = volume of firm output
y_s = supply or supply curve (in Chapters 5, 6 : if labour supply is ample)
cap = y_{max} = maximum production capacity
y_d = demand or demand curve
MC = marginal cost
AC = average cost
model = 1 if output is below maximum given the stock of capital("demand model")
model = 0 if output is maximal given the stock of capital ("supply model")

Bonds Market

OVD_{ij} = stock of bonds issued in country j desired by citizens (non-firms) in country i in currency j
ζ_{ii} = parameter determining the dependency of OVD_{ii} from r_i
ζ_{ij} = parameter determining the dependency of OVD_{ii} from foreign interest rates and expected depreciations
V_i = financial wealth (non-firm) in country i in currency i (portfolio)
TT = holdings of bonds by firms
r_i = interest rate (nominal)
O_i = total stock of bonds issued in i
O_{ij} = number of bonds issued in j held in i
OO_R = interest earnings of entrepreneurs
OO_C = interest earnings of wealth holders
OO = total private (non-firm) interest earnings

O_g = government interest payments

O_p = interest paid by firms

B = interest revenues on firm holdings of bonds

δkP_y = depreciation charges

α_1 = percentage of the current government deficit financed through monetary means (policy instrument)

MP = expansion of the money supply due to open market operations

$\overline{MP}$ = percentage of last period's number of bonds bought by the central bank (policy instrument)

Prices and exchange rates

P_{y_i} = price level of a product produced in i in currency i

$P_{m_{ij}}$ = price of imports in i out of j in currency i after tariffs

P_m = average import price level (after tariffs)

P = price of final private absorption (consumer price level)

ER_i = price of one unit of gold in currency i (ER_4 is the numerary of the system)

$\overline{ER_iA}$ = percentage increase in the price of gold in terms of currency i.

ER_{ij} = exchange rate between currencies i and j : number of currency i per unit of currency j

$\dot{ER}^e_{ij}$ = expected rate of depreciation of currency i in terms of currency j

$1/r_i$ = price of a consol issued in country i

P_L = wage in the market sector

Balance of Payments

BB = balance of payments measured in gold

SN = balance on trade account in home currency

KOB = balance on the service account in home currency

KAB = balance on the capital account in home currency

S1N' = balance on trade account (of country 1) that would have been obtained if exchange rates from the previous period would have applied

KOB1' = balance on debt service account (of country 1) that would have been obtained if exchange rates from the previous period would have applied

KAB1' = balance on capital account (of country 1) that would have been obtained if exchange rates from the previous period would have applied

coefficients (in brackets: standard value)

α fixed amount of labour per unit of output (1)

κ fixed amount of capital per unit of output (1)

δ rate of depreciation of fixed capital (without mon.sector 0.2,else 0.1)

Θ life span of a machine (without mon. sector 5, else 10)

β_0 scale factor in production function (1)

ε ratio of nominal imports over nominal home consumption (0.08889 per trade flow)

Ω critical value for unemployment to exert no influence on wages if a Philips mechanism is assumed (2.982107355)

γ coefficient indicating the amount of extra material government consumption per extra civil servant

π rate of growth in labour force (0)

λ_1, λ_2, b_1, b_2 zero/one coefficients, see "labour market"

q degree to which expected profits lead to net (dis)investments = coefficient c536 of equation 4.2 (30)

β elasticity of production with regard to labour input (0.8)

miscellaneous

W = welfare

e (superscript) = value of variable concerned expected for period t+2 unless subscript indicates that the expectation regards period t+1

B (superscript) = block countries

* (superscript) = foreign, cq. countries not included in block

w (superscript) = world

>> = much larger than

<<	= much smaller than
≈	= about zero
$PV(P^{e}_{y_{t+1}})$	= present value in t of the expected price of a machine bought one period ahead
FA'	= weighted rate of growth in real final demand during periods t -ϑ,...,t
'gap'	= difference between k* and the stock of capital that would result if no net investments were planned (Chapter 6)
U	= utility (Chapter 6)
ICM	= international capital mobility (Chapter 7)

symbols in tables regarding Chapters 3 to 6

WELF1	welfare of country 1
MODEL1	kind of model (where 0.0000 indicates a supply model)
Y1	volume of sales
CO1	volume private consumption of home produced goods
I1	volume of (gross) investments
EX1	volume of exports
M1	import volume
YL1 N	nominal labour income earned in private sector
YR1 N	nominal value of gross profits
PL1	price of labour in private sector
WB1	disposable real income per labourer in private sector
P1	price level of (total) consumption
PY1	price of home produced goods
K1	volume of physical capital
LM1	number of workers in private sector
U1	unemployment rate (in %)
KOPT1	optimal volume of physical capital (in view of expected prices of factors of production)
ID1	net investment decision
F1	government budget surplus
R1	interest rate on capital market
S1 N	balance on trade account in home currency, in nominal terms
BB1	surplus on balance of payments (in gold), in nominal terms
ER12	exchange rate: amount of currency 1 per unit of currency 2
M12	volume of imports in country 1 out of country 2
PY1 E	price of home produced goods expected for two years ahead
PK1 E	price of capital expected for two years ahead
PL1 E	price of labour expected for two years ahead
CAP1	maximum output of the actual stock of capital if labour is fully absorbed
YS1	supply of products if labour supply is ample
Y1 E	production expected for two years ahead
BR1	revenue of profit tax
TL1	tax rate on labour income

TR1	tax rate on profits
R1	interest rate on capital market
O1	number of (irredeemable) bonds issued in country 1
OVD11	stock of bonds demanded by households in country 1 issued in country 1 in value, in currency 1
OVD21	stock of bonds demanded by households in country 2 issued in country 1 in value, in currency 1
OO1	interest earnings accruing to households in country 1 in currency 1
OP1	interest payments by firms in country 1
OG1	interest payments by government in country 1
V1	wealth
KOB1	surplus on service account of country 1
KAB1	surplus on capital account in country 1
BB1	surplus on balance of payments (in gold), in nominal terms

symbols of impulses (i.c. for country 1; in main text all impulses are 'barred')

TL1 A	change (in %-points) in labour tax rate
TR1 A	change (in %-points) in profit tax rate
T12 A	tariff on imports out of country 2
T13 A	tariff on imports out of country 3
T14 A	tariff on imports out of country 4
G1 A	additional government purchases
LG1 A	additional civil servants
PL1 A	autonomous increase in private wages
PLCS1 A	increase in income per civil servant relative to private wages
PLU1 A	increase in income per unemployed relative to private wages
α11 A	monetary financing of government deficit
MP1 A	autonomous increase in money supply
ER1 A	percentage of devaluation

SUMMARY

SIER A Macro-Economic Computer Game on Cooperation and Conflict in International Economics

This dissertation presents the 'SIER' Game (Simulation of International Economic Relations), a four country computer game developed with strong programming support of the Computer Department (DRC) of Tiburg University. The game was primarily designed as an aid for teachers of standard international macro-economics. The game should show players how hard it is to reach certain goals of economic policy in an interrelated world economy. In addition to its educational purposes, the Game can also serve as a research tool.

The SIER Game consists of a series of games ranging from relatively simple to rather complex. Ideally students play games incorporating several successive levels of complexity. All levels have a large number of behavioural and technical relationships in common and their formal structure (i.e., the method of playing) is identical. (It is not necessary to know anything about computers to play any of the versions.)
The versions differ mainly in the production function (complementary vs. perfectly substitutable factors of production), the investment function, the import equation, the possible inclusion of a monetary block (with or without international mobility of capital) and the possible option (for players) to choose between fixed but adjustable and flexible rates of exchange.
The game leader chooses the appropriate version. His choice also determines the instruments available to players (see below). Moreover, the game leader has the option to change the coefficients of the model. He can change 'details' of the model in the same way. He may, for example, include an immediate or lagged influence of consumer prices, labour productivity and/or the rate of unemployment on the nominal wage rate.

Chapter 1 describes the way the Game is played.

Four player groups are formed, each representing the government of a country. The choice of four countries is not completely arbitrary. It facilitates trade blocks, for example, and, although the computer uses a symmetric four-country model, if two or three countries cooperate, the 'world', in fact, becomes asymmetric.
Each group is assigned to maximize 'welfare' in its country by the end of the Game through proper manipulation of its macro-economic instruments over a number of periods. The group with the highest welfare has won the game.
'Welfare' is a figure based on the five goals of economic policy accepted in many western economies. It is determined by the real private absorption of goods and services, the rate of unemployment, price changes, the surplus on the balance of payments and, alternatively, the rate of interest or the government deficit.

The policy instruments per player group are the level of material government expenditures, the number of civil servants, the tax rate on labour income, the tax rate on profits and interest proceeds, 3 (possibly different) import tariffs, wage policy, the salary of civil servants, the income per unemployed, exchange rate policy or (alternatively) a system of flexible exchange rates. If a monetary sector is included, open market policy and the extent to which the government deficit is financed through bonds are additional instruments.

During the decision making process, players can use the information on their terminal screen that is either shown automatically or available on request (including lists of symbols).
This information is not only available for the current period and for their own country, but also for all previous periods and for any other country.

A game is closed by an evaluation based on a computer printout of all interventions and the developments in the main economic variables during the game. This printout is available to every player immediately after the computer session.

Chapter 2 describes the relationships common to all of the versions of the SIER Game. These common features are combined with one of two available investment equations and one of two available production functions. The resulting combinations can be classified as dynamic non-linear symmetric systems with four large countries and imperfect international competition in both product and financial assets markets.
The respective combinations are discussed in Chapters 3 to 6. They are illustrated by a description over time of the impact of unilateral or world-wide fiscal policy, supply-side policy, wage policy and, if applicable, monetary policy, under alternative initializing assumptions. Chapters 1 to 6 can be regarded as a guide for future game leaders.

Chapter 7 summarizes the impacts of those policies and compares the conclusions regarding fiscal and monetary policy to those drawn in standard economic literature. Moreover, it discusses the merits of the SIER Game as a framework for other types of research by providing some preliminary examples.

SAMENVATTING

SIER Een Macro-Economisch Computerspel over Samenwerking en Conflict in de Internationale Economie

De dissertatie behandelt het 'SIER Spel' ('Simulation of International Economic Relations'), een computerspel voor vier landen. De ontwikkeling van de programmatuur is in belangrijke mate ondersteund door de Dienst RekenCentrum van de Katholieke Universiteit Brabant. Het spel is allereerst bedoeld als hulpmiddel bij het onderwijs in de internationale macro-economie. Het moet aan de spelers tonen hoe moeilijk het is om bepaalde doeleinden van economische politiek te bereiken in een geïntegreerd wereldbestel. Niet alleen voor onderwijs, maar ook voor onderzoek kan het spel een dienstig hulpmiddel vormen.

Het SIER Spel bestaat uit een serie spelen, variërend van makkelijk tot moeilijk. Idealiter spelen studenten versies van een opeenvolgende moeilijkheidsgraad. Alle spelniveau's hebben een aantal technische en gedragsrelaties gemeen en bovendien is de spelformule steeds dezelfde. In geen der varianten hoeven de spelers voorkennis van computers te bezitten.
De varianten verschillen in hoofdzaak voor wat betreft de produktiefunctie (complementaire dan wel perfect substitueerbare produktiefactoren), de investeringsfunctie, de invoerfunctie, de eventuele opname van een monetaire sector (al dan niet met internationale kapitaal-mobiliteit) en het wel of niet bestaan van de mogelijkheid (voor spelers) om te kiezen tussen vaste maar aanpasbare en flexibele wisselkoersen.
De spelleider kiest de meest geschikte versie. Daarmee bepaalt hij dan tevens de instrumenten van economische politiek die de spelers zullen kunnen hanteren (zie onder). Bovendien kan de spelleider de coëfficienten van het model wijzigen, waardoor hij de spelvariant op 'detailpunten' kan wijzigen. Op die manier kan hij bijvoorbeeld een onmiddellijke of vertraagde invloed bewerkstelligen van inflatie, arbeidsproduktiviteit en/of werkloosheid op de lonen.

In Hoofdstuk 1 wordt de manier beschreven waarop het spel wordt gespeeld.

Er worden vier spelersgroepen gevormd, waarbij elke groep geacht wordt de regering van een land te vertegenwoordigen. De keuze van vier landen is niet volledig arbitrair. Zo opent dit de mogelijkheid van handelsblokken en als twee of drie landen samenwerken ontstaat er een asymmetrische 'wereld' hoewel de computer gebruik maakt van symmetrisch model.
Elke groep moet er voor zorgen dat op het einde van het spel de 'welvaart' in zijn land het hoogst is, te bereiken door het voeren van een geëigend macro-economisch beleid in de successievelijke perioden. Het land met de hoogste welvaart heeft gewonnen.
Hierbij wordt 'welvaart' gemeten aan de hand van de vijf in vele westerse landen algemeen aanvaarde doelstellingen van economisch beleid. Zij hangt af van de reële private absorptie van goederen en diensten, het werkloosheidspercentage, de mate van prijsstabiliteit, het betalingsbalanssaldo, en ofwel de rentestand ofwel het overheidstekort.

Elke spelersgoep heeft de volgende instrumenten tot zijn beschikking: het niveau van de materiële overheidsconsumptie, het aantal ambtenaren, de belastingvoet op arbeidsinkomen, die op winstinkomen en renteinkomen, 3 (mogelijk verschillende) importtarieven, loonpolitiek, het niveau van de ambtenarensalarissen, het niveau van de uitkeringen, en de hoogte van de wisselkoers dan wel de overgang naar flexibele wisselkoersen. Indien een spel gespeeld wordt met monetaire sector, wordt daar aan toegevoegd openmarktpolitiek en de mate waarin het overheidstekort via obligatie-uitgifte wordt gefinancierd.

Gedurende hun besluitvormingsproces kunnen spelers gebruik maken van de informatie die hetzij automatisch, hetzij op hun eigen verzoek op hun terminalscherm getoond wordt. (Tot deze laatste vorm van informatie behoren ook de symbolenlijsten.) Alle informatie is zowel voor de lopende periode voor het eigen land beschikbaar, als voor andere perioden en/of andere spelersgroepen.

Een spel wordt afgesloten door middel van een evaluatie aan de hand van een computer-uitdraai met betrekking tot alle beleidsinterventies en de ontwikkelingen in de belangrijkste economische grootheden in de loop van het spel.

In Hoofdstuk 2 worden de economische relaties beschreven die alle spelversies gemeen hebben. Die relaties worden in het SIER Spel gecombineerd met één van de twee beschikbare produktiefuncties en met één van de twee beschikbare investeringsfuncties. De dan resulterende combinaties kunnen geclassificeerd worden als niet-lineaire dynamische symmetrische systemen met vier grote landen en internationaal imperfecte concurrentie zowel op de goederen-markten als op de markten voor financiële activa.
Genoemde combinaties worden beschreven in de Hoofdstukken 3 tot en met 6. Zij worden geïllustreerd via een beschrijving in de tijd van de gevolgen van (eenzijdige dan wel wereldwijde) begrotings-politiek ("fiscal policy"), aanbod-politiek ("supply side policy"), loonpolitiek en, indien van toepassing, monetaire politiek. Dit alles onder alternatieve vooronderstellingen.
De Hoofdstukken 1 tot en met 6 kunnen beschouwd worden als leidraad voor toekomstige spelleiders.

In Hoofdstuk 7 worden de effecten van deze vormen van beleid samengevat en worden de conclusies m.b.t. begrotings- en monetaire politiek vergeleken met die welke in de standaardliteratuur worden getrokken. Bovendien worden in dat hoofdstuk andere mogelijkheden van het SIER Spel voor het verrichten van onderzoek belicht middels een aantal in de toekomst nog nader uit te werken voorbeelden.